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# Marsh Zones and Vegetative Types in the Louisiana Coastal Marshes.

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The Louisiana State University and
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Ph.D., 1970
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MARSH ZONES AND VEGETATIVE TYPES IN THE
LOUISIANA COASTAL MARSHES

A Dissertation

Submitted to the Graduate Faculty of the
Louisiana State University and
Agricultural and Mechanical College
in partial fulfillment of the
requirements for the degree of
Doctor of Philosophy

in

The Department of Botany and Plant Pathology

by
Robert Henry Chabreck
B.S., Louisiana State University, 1956
M.S., Louisiana State University, 1957
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# ABSTRACT

Marsh zones and vegetative types were sampled in the Louisiana Coastal Marshes in August, 1968. Sampling was done to determine the plant species composition and vegetative coverage of the various areas. The levels of water and soil salinity and soil organic matter were determined for each marsh zone and vegetative type. Samples were taken along 39 transect lines equally spaced along the coast. Two helicopters were used for transportation and vegetation estimates were made at 0.25-mile intervals along each transect line. Landings were made at 2-mile intervals for collecting soil and water samples, and for ground measurements of vegetation.

A map prepared from this study revealed that the Louisiana Coastal Marshes included 4.2 million acres. The Chenier Plain Marsh Zone contained 1.2 million acres, the Inactive Delta Marsh Zone contained 2.7 million acres and the Active Delta Marsh Zone had 0.3 million acres. The fresh and brackish vegetative types total 61 percent of the coastal marsh in almost equal amounts, the saline vegetative type made up 25 percent of the area and the remainder was the intermediate vegetative type.

A total of 118 species of vascular plants were located along the transect lines. *Spartina patens* was present in greatest amounts, making up one-fourth of the vegetation in the coastal marshes. Other major species were *Spartina alterniflora*, *Panicum hemitomon*, *Distichlis spicata* and *Sagittaria falcata*.



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The vegetation varied considerably among vegetative types. with each type having characteristic groups of plants. Also, variation was found in the plant species composition between marsh zones. Vegetation coverage of vegetative type and marsh zones was similar for all areas in the coastal marshes.

Water salinities for the coastal marshes averaged 18 ppt in the saline vegetative type, 8 ppt in the brackish, 3 ppt in the intermediate and 1 ppt in the fresh. Soil organic matter showed little variation between the Chenier Plain and Inactive Delta Marsh Zones, but an inverse relationship was found between these two zones and the Active Delta Marsh Zone.



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# INTRODUCTION

The Louisiana Coastal Marshes are one of the unique geographic areas of North America. This area originated from alluvial deposits of the Mississippi River and its distributaries, accumulating over the centuries to form a broad, flat plain. These marshes and associated water bodies cover over 4 million acres and encompass the full coastline of the state, varying in width from 15 to 50 miles. Since these marshes extend inland from the Gulf of Mexico for such great distances, widely varying ecological conditions occur such as water salinity, drainage and soils.

Each set of conditions produce characteristic plant communities (Brown, 1936; Penfound and Hathaway, 1938). Likewise, the plants occupying a particular area are indicative of the edaphic factors occurring in the area. Each species is limited to a specific environment and as long as this prevails the species will generally grow in the area. However, a change in conditions will usually result in a change in plant species (O'Neil, 1949). Chamberlain (1957) stated that natural vegetational changes appeared to be an adjustment of the vegetation to development of marsh soil and variation in salinity and water levels. Generally, the set of conditions in a particular area are favorable for the growth of a number of species.

The species composition of a certain type of marsh is determined by the species represented and the environmental factors present. The species composition will vary between areas having similar environmental



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conditions; however, because of differential growth habits, certain species consistently occur in greater proportions than others.

The Louisiana Coastal Marshes are among the most productive natural areas on earth, and the abundance of herbaceous plant materials has greatly enhanced the value of this area for fur-bearing animals and waterfowl (St. Amant, 1959). Cattle grazing is also an important land use practice, and the water bodies associated with coastal marshes are well known for their high production of marine organisms.

The value of the coastal marshes and the unique situation existing there make it important that the vegetative conditions be investigated at this time. A rapidly expanding human population is placing increasing demands on such wilderness areas, and within the next few decades drastic changes will likely occur. Within the past two decades mineral exploration and development have resulted in a considerable change to the marsh vegetation on a local basis, and conditions at present indicate that the trend will continue. Increasing demands on land and freshwater will certainly affect the coastal marshes. The degree to which they will be affected is unknown; however, unless the botanical features are documented on a broad basis at this time with techniques which can be duplicated at a later date, accurate information as to the amount of change will never be known.

The Louisiana Cooperative Wildlife Research Unit was asked in April, 1968 to prepare a current vegetative type map of the Louisiana Coastal Marshes. This information was needed by the Louisiana Wild Life and Fisheries Commission and the U. S. Corps of Engineers as part of other studies on the freshwater needs of the coastal area of Louisiana.

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The U. S. Corps of Engineers agreed to provide 50 days of helicopter flight time to aid this investigation.

While collecting data essential for preparation of the vegetative type map, ample time was available to gather other information regarding the vegetation in this broad area. A study was designed to determine the plant species composition and vegetation coverage by vegetative types along the coast. Also, plans were made to investigate the soil and water salinity and soil organic matter content of different vegetative types.

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## DESCRIPTION OF THE AREA

### Topography

The entire Louisiana coast was included in this study, extending from Texas to Mississippi, and from the Gulf of Mexico inland to the northern boundary of the marshes. The northern edge of the marsh extends slightly beyond the Intracoastal Waterway, with a few exceptions.

The Louisiana Coastal Marshes are bound on three sides by bodies of water, and in many areas lakes, bayous and canals are so abundant that the marsh appears not as a land mass at all, but rather, a vast region of small islands. In other regions the opposite exists, and marsh vegetation grows in vast unbroken stands covering as much as 1 square mile.

The coastal marshes, in general, are without distinct relief features. The marsh in most areas is only slightly above mean Gulf level. Most noticeable are the low natural levee ridges along tidal channels and larger streams flowing into or through the marsh (Lytle and Driskell, 1954). Also, Brown (1936) reported a striking contrast between the vegetation on Indian mounds and middens and that of the surrounding marshes. The construction of artificial leveees and spoil deposits in recent years have greatly altered the topographic features in practically all areas of the coastal marshes (Plate 1).



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Plate 1

Fresh marsh with Salix nigra marking the location of spoil deposits along canals

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Coastal Origin

The Louisiana Coastal Marshes are a product of the Mississippi River. During the Recent Period seven Mississippi River delta systems have developed because of diversions in the river channel. The large number of deltas has caused considerable variation in the physiography of the area. During the coastal development process Prairie Formation deposits of Pleistocene Age were overlain with a wedge of recent sediment primarily by the Mississippi River (Kniffen, 1968).

The coastal region has been divided into two segments on a basis of origin and physiography. The area east of Vermilion Bay and occupying two-thirds of the coastal region was designated as the Deltaic Plain. The Deltaic Plain is the site of the various delta systems. The area west of Vermilion Bay has been named the Chenier Plain and was formed from river sediment swept westward by longshore currents in the Gulf of Mexico (Coleman, 1966).

Over a period of some 8000 years the Mississippi River has altered its course periodically, forming new deltas with each move. When viewed at the present time, older deltas show less rate of change than the younger deposits. The older deltas, having had more time for compaction, subsidence and wave modification show greater stability (Morgan and Larimore, 1957).

Continuous subsidence over a long period of years has modified the older deltas so that original deposits are far below sea level. Breton Sound, Chandeleur Sound, Barataria Bay and Timbalier Bay are typical areas which were formerly marshes on the outer reaches of deltas but were lost because of subsidence. O'Neil (1949) described such water

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bodies as drowned marsh. Within the same delta systems submergence of original deposits has also taken place further inland. However, subsidence is less noticeable here because of the extensive floating marshes which have developed (Russell, 1942).

The developmental process of the Chenier Plain was considerably different from that of the Deltaic Plain. Silt and clay sediment swept westward by longshore currents gradually accumulated as mud flats against the shoreline. The amount of material carried and the duration of flow determined the extent of the buildup. The mud flats soon became occupied by salt-tolerant vegetation and new marsh was thus created (Coleman, 1966).

The building process in the Chenier Plain continued until a change in the river's course resulted in a loss of sedimentary material. Once the building process ceased, the new marsh came under attack by wave action. Shoreline retreat then followed, with a corresponding formation of local beach deposits. The beach deposit remained along the point of wave attack until another change in course caused a resumption in the buildup along the shoreline. This process caused the marshes to again advance seaward leaving the beaches stranded (Russell and Howe, 1935).

The stranded beaches or cheniers as they are termed locally extend in an east-west direction and have a strategic role in the drainage patterns of the Chenier Plain. In contrast, topographic features of the Deltaic Plain, such as the natural levees of past and present drainage systems, generally run in a north-south direction.

O'Neil (1949) used the term Prairie Marshes in describing the marshes of the Chenier Plain in Southwestern Louisiana, and characterized

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the area as being poorly drained and having shallow peat soils. He classified the marshes of the Deltaic Plain as Delta Marshes and Sub-delta Marshes and stated that the basic geology of the areas was similar. Noticeable differences occurred, however, in the plant communities of the two areas as a result of subsidence, peat deposits, and salinity. The marshes of the Deltaic Plain are referred to as marsh zones in this study and termed Inactive Delta Marsh Zone and Active Delta Marsh Zone (Figure 1).

The Active Delta Marsh Zone which consisted of the present Mississippi River Delta was greatly influenced by the vast amount of fresh water supplied by the river and its distributaries. Daily tidal action in the older Inactive Delta Marsh Zone and the absence of a sizeable fresh water flow resulted in saline conditions over a large portion of the area.

## Soils

The coastal marsh soils are generally classified as peats, mucks, and clays with all occurring in various proportions. The dominant morphological characteristics are the dark brown and black colors of the peats, mucks and organic clays, and the gray colors associated with water-logged, reduced soil conditions (Lytle, 1968).

The soil materials are silts, silty clays and clays of recent alluvial origin, plus marine silts and clays, overlain at various locations by peats and mucks (Lytle and Driskell). The depth of the organic soil is determined by the amount of subsidence and the vegetative history of a particular area. According to Russell (1942), the organic layer has veen found at depths ranging from a few inches down to depths of 20 feet.

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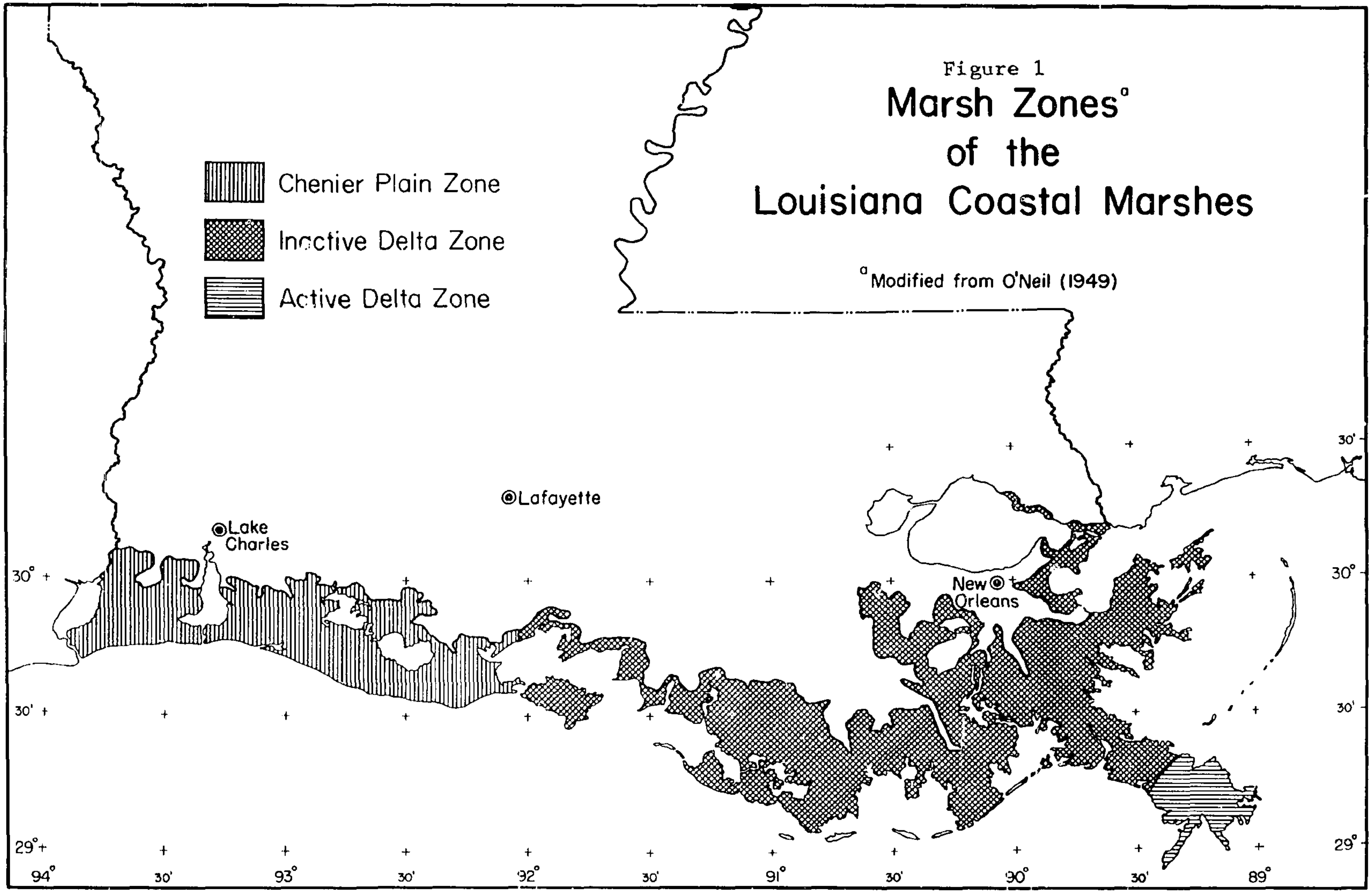


Figure 1
Marsh Zones[a] of the Louisiana Coastal Marshes

[a] Modified from O'Neil (1949)

The organic soils are classified on a basis of the stage of decomposition. Dachnowski-Stokes (1940) classified peat as soil which has a brown or black color and contains plant parts only partially decomposed and generally with over 50 percent organic matter. Mucks are usually black or dark gray and contain organic material which is finely divided and well decomposed with none of the plant parts identifiable. The organic content of much usually ranges from 15 to 50 percent and soils with less than 15 percent organic matter are classified as mineral soil.

## Tides

The tidal cycle in the coastal areas of Louisiana is controlled largely by tides in the Gulf of Mexico, although local conditions have some influence. Like most large bodies of water the dynamics of tide in the Gulf of Mexico is a complicated problem. The irregular shape of its basin and connections with the Atlantic Ocean and Caribbean Sea cause co-oscillation with the tidal movements in those bodies of water (Marmer, 1954).

At any location the tides not only vary in range from day to day, but also from month to month and year to year. The changes in range and character of tides are influenced primarily by changing positions of the moon in relation to the earth and sun, with different localities responding in a different fashion. The tidal cycle follows the moon cycle with two principal types of fluctuations within the cycle, the daily tide and the semidaily tide. According to Marmer (1954) the fluctuations occur at intervals with an average length of 24 hours and 50 minutes along the northern Gulf coast.

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Under normal conditions, Gunter (1967) reported that at the beginning of the cycle tides are the daily type with one maximum and one minimum each day. The maximum fluctuation is 26 inches which occurs only once a month. Then, every succeeding day it declines slightly until the variation is only two or three inches a day with the tide standing a little above mean low. This if further complicated by a change over to semidaily tides during the period of small fluctuation. The semidaily tides have two high waters and two low waters in a tidal day with an interval between highs of about 12 hours and 30 minutes (Marmer, 1954).

The periodic rise and fall of the tide is subject to the effects of changing weather conditions. Changing meteorological conditions may change the level of the water from which the tides rise and fall, altering both the time of occurrence and the levels of high and low tides. With strong southerly winds Gulf waters will pile up along the Louisiana coast and spread inland through the many bays, bayous and canals. Periods of prolonged winds frequently result in inundation of the marshes. The depth of flooding is determined by the duration and velocity of the winds, the elevation of the marsh and its distance from the Gulf. Extremely high tides are associated with tropical storms and hurricanes, and tide water may be pushed inland for considerable distances.

During the winter strong northerly winds have an opposite effect and at times tides as low as 2 feet below normal are not uncommon. Marshes drained by tidal channels will be practically dry at such times. Channel size determines the rate of water exchange, and interior marshes connected to the Gulf by large channels are influenced to a greater

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extent by tides than marshes with small drainage systems. Gunter (1967) reported that heavy local rainfall would raise water levels in back bays and other coastal areas having slow drainage. Such rains have a slight disturbance on tide levels, but the effects are only temporary. According to Nichols (1959), periods of high water during rainy seasons in adjacent upland areas may curtail the tidal effect in the marsh streams until the freshwater level is lowered to that of the current high tide level.

A study of tide levels along the central Louisiana coast at Marsh Island by Chabreck and Hoffpauir (1962) revealed considerable monthly differences in mean tides. During the period included, 1958 and 1959, the area was not influenced by tropical storms or hurricanes; therefore, the tide levels as shown in Table 1 could be considered normal. The data were collected using continuous water level recorders and showed that tides ranged from a mean high of 1.26 feet above sea level in September to a mean low of minus 0.62 feet in December. The mean tide level over the 24-month period was 0.43 feet above sea level. Normal marsh elevations on the Chenier Plain average about one foot above sea level (Nichols, 1959), and because of subsidence, elevations on the Deltaic Plain average even less. Although normal high tides commonly inundate the marshes, mean marsh levels are several inches above mean tide levels, thus favoring the growth of emergent vegetation.

## Climate

The climate along the Louisiana coast is influenced greatly by its subtropical latitude and its proximity to the Gulf of Mexico. The marine tropical effect results from the fact that the average water

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Table 1. Monthly tide levels along the Central Louisiana coast, 1958-59[a]

| Month | Mean High Tide | Mean Low Tide | Mean Water Level | Highest Individual Tide | Lowest Individual Tide |
|---|---|---|---|---|---|
| | | | Feet | | |
| January | .39 | -.35 | .02 | 1.5 | -2.0 |
| February | .56 | -.26 | .15 | 1.6 | -1.8 |
| March | .60 | -.18 | .21 | 1.3 | -1.5 |
| April | .78 | .09 | .43 | 1.2 | - .7 |
| May | 1.13 | .40 | .76 | 2.4 | - .7 |
| June | 1.19 | .18 | .69 | 1.7 | - .7 |
| July | .83 | -.06 | .39 | 1.5 | -1.0 |
| August | .83 | .11 | .47 | 1.6 | - .8 |
| September | 1.26 | .69 | .97 | 2.6 | - .2 |
| October | 1.06 | .39 | .72 | 1.8 | - .5 |
| November | .85 | .07 | .46 | 1.5 | -2.1 |
| December | .37 | -.62 | -.12 | 1.4 | -2.2 |
| Annual | .82 | .04 | .43 | 2.6 | -2.2 |

[a]From Chabreck and Hoffpauir, 1962.

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temperature of the Gulf along the Louisiana shore ranges from 64°F. in February to 84° in August (Sanders, 1959). Prevailing southerly winds in summer provide moist, semi-tropical weather and frequently produce afternoon thundershowers. Whenever westerly or northerly winds interrupt the prevailing moist conditions during the summer, hotter and dryer weather results. During the winter the state is subjected to alternating cold continental air and warmer tropical air, causing drastic variations in climatic conditions.

A comparison of mean monthly temperatures as shown in Table 2 lists January as the coldest month and August as the hottest. Mean temperatures vary only slightly going from west to east across the state. The mean temperature in the spring and summer of 1968, prior to this study, compared favorably with the 25-year average. Temperatures in February averaged about 9°F. below normal; otherwise, monthly temperature averages in 1968 were with 2° of the 25-year average. According to Kniffen (1968) the growing season along the Louisiana coast or the period between the last freeze in the spring and the first in the fall averages 317 days between February 1 and December 15.

The Louisiana coast generally has an abundance of rainfall with annual averages ranging from 57.86 inches at Lake Charles to 66.14 inches at Morgan City (Table 3). The rainfall is fairly well distributed throughout the year with the maximum occurring in July and the minimum in October. Annual precipitation during 1968 was below the 25-year average at all stations checked, however, no outstanding drought periods were noted, instead totals for all months fell below average, with noticeable exceptions.

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Table 2. A comparison of the twenty-five year mean monthly temperature[a] with the 1968 mean monthly temperature[b] along the Louisiana coast

| | Lake Charles | | Lafayette | | Morgan City | | Houma | | New Orleans | |
|---|---|---|---|---|---|---|---|---|---|---|
| Month | 25 yr. | 1968 | 25 yr. | 1968 | 25 yr. | 1968 | 25 yr. | 1968 | 25 yr. | 1968 |
| | Degrees Fahrenheit | | | | | | | | | |
| Jan. | 52.6 | 50.8 | 54.1 | 51.5 | 56.5 | 53.1 | 56.9 | 54.0 | 54.9 | 51.6 |
| Feb. | 55.9 | 46.6 | 56.5 | 46.7 | 58.6 | 49.5 | 58.6 | 49.8 | 57.4 | 47.2 |
| March | 60.6 | 58.2 | 61.3 | 57.4 | 63.0 | 58.5 | 62.7 | 59.4 | 61.7 | 55.9 |
| April | 68.0 | 70.5 | 68.0 | 69.6 | 68.9 | 71.4 | 68.8 | 71.6 | 68.3 | 68.1 |
| May | 84.5 | 74.8 | 74.8 | 74.6 | 75.5 | 75.1 | 74.9 | 75.2 | 74.6 | 74.1 |
| June | 80.7 | 79.8 | 80.8 | 80.1 | 81.1 | 80.9 | 80.1 | 80.7 | 80.5 | 80.4 |
| July | 82.2 | 81.5 | 82.0 | 80.8 | 82.1 | 81.7 | 81.4 | 80.9 | 81.8 | 82.4 |
| Aug. | 82.3 | 81.9 | 82.0 | 80.7 | 82.3 | 81.9 | 81.6 | 81.2 | 82.2 | 81.0 |
| Sept. | 78.6 | 75.6 | 78.1 | 75.9 | 78.9 | 77.3 | 78.2 | 77.3 | 79.5 | 75.4 |
| Oct. | 70.3 | 69.7 | 69.6 | 70.3 | 71.1 | 72.3 | 70.3 | 72.0 | 71.4 | 68.5 |
| Nov. | 59.3 | 56.9 | 59.1 | 56.7 | 60.7 | 58.8 | 60.7 | 59.9 | 60.9 | 55.5 |
| Dec. | 54.0 | 52.2 | 54.9 | 52.4 | 56.9 | 53.6 | 57.3 | 54.9 | 56.1 | 50.8 |
| Annual | 68.3 | 66.5 | 68.4 | 66.4 | 69.6 | 67.8 | 69.3 | 68.1 | 69.1 | 65.9 |

[a]From Sanders (1959) and includes the period from 1931 through 1955.

[b]From U. S. Weather Bureau (1969).

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Table 3. A comparison of the twenty-five-year mean monthly precipitation[a] with the 1968 monthly precipitation[b] along the Louisiana coast

| Month | Lake Charles 25 yr. Ave. | Lake Charles 1968 | Lafayette 25 yr. Ave. | Lafayette 1968 | Morgan City 25 yr. Ave. | Morgan City 1968 | Houma 25 yr. Ave. | Houma 1968 | New Orleans 25 yr. Ave. | New Orleans 1968 |
|---|---|---|---|---|---|---|---|---|---|---|
| | Inches | | | | | | | | | |
| Jan. | 4.82 | 3.89 | 5.47 | 3.53 | 5.00 | 1.42 | 4.18 | 1.60 | 4.68 | .54 |
| Feb. | 4.53 | 2.68 | 4.23 | 3.43 | 5.06 | 3.59 | 3.85 | 3.67 | 3.97 | 3.02 |
| March | 4.76 | 2.76 | 4.63 | 3.05 | 5.07 | 2.76 | 5.25 | 2.57 | 5.90 | 3.49 |
| April | 4.27 | 2.39 | 4.69 | 2.56 | 4.52 | 5.66 | 4.61 | 7.27 | 5.40 | 3.59 |
| May | 4.73 | 3.16 | 5.09 | 6.43 | 4.58 | 3.07 | 4.26 | 2.10 | 5.54 | 4.13 |
| June | 5.08 | 8.90 | 5.11 | 4.65 | 5.29 | 6.43 | 6.09 | 3.97 | 5.63 | 3.69 |
| July | 6.93 | 7.82 | 7.06 | 3.30 | 8.73 | 6.78 | 8.45 | 5.03 | 5.89 | 4.96 |
| Aug. | 4.66 | 3.59 | 6.11 | 3.76 | 7.53 | 6.66 | 7.34 | 7.40 | 5.64 | 4.78 |
| Sept. | 4.53 | 3.11 | 4.10 | 3.90 | 7.14 | 5.77 | 6.31 | 3.39 | 5.06 | 2.44 |
| Oct. | 3.44 | 2.38 | w.73 | 1.34 | 2.99 | 3.93 | 3.43 | .63 | 3.18 | 1.40 |
| Nov. | 4.34 | 5.83 | 4.39 | 6.65 | 4.55 | 5.60 | 4.47 | 4.59 | 4.09 | 4.97 |
| Dec. | 5.76 | 4.73 | 5.58 | 3.16 | 5.68 | 5.10 | 5.15 | 8,53 | 4.67 | 6.14 |
| Annual | 57.86 | 51.24 | 59.19 | 45.76 | 66.14 | 56.77 | 63.39 | 50.75 | 59.65 | 43.15 |

[a]From Sanders (1959) and includes the period from 1931 through 1955.

[b]From U. S. Weather Bureau (1969).

Hurricanes and tropical storms with strong cyclonic winds, high tides and torrential rain are occasional visitors to the coastal region between June and November (Nichols, 1959). These storms generally approach Louisiana from the southeast and move inland with terrific force. Over the past 15 years 5 major hurricanes have struck the Louisiana coast greatly altering conditions in the region.

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## METHODS AND MATERIALS

### Means of Travel

Because of the size of the area to be sampled, limited access and the nature of the terrain, helicopters were the only logical means of transportation. Many of the marsh plants are annuals; consequently, limiting the sampling time to as short a period as possible was desirable. This would eliminate sampling time or season as a source of variation among zones along the coast. One area sampled in May could not be accurately compared with another sampled in August. Therefore, using two helicopters sampling was begun on August 7, 1968, and completed on August 22, with the entire sampling period taking only two weeks. Sampling in August was desirable because most plants were mature enough at this time for quick identification. The helicopters (Bell Model 47G4A) were capable of making normal maneuvers with three men, including the pilot, and with a cargo of 75 pounds.

Sampling points were located along predetermined transect lines. Visual estimates were made of the vegetation with the helicopter hovering over the sampling point. Periodic landings were made in order to take ground measurements of the vegetation for a test of the accuracy of visual estimates from the air and to collect soil and water samples. The number of landings was held to a minimum in the interest of time and safety.



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## Sampling Stations

Sampling stations were placed along equally spaced north-south transect lines, beginning at Sabine Lake and continuing eastward to Pearl River. Original plans were to place the transect lines on township lines, since these were clearly marked on most maps. However, this idea was abandoned because township lines usually represent property lines and are the site of man-made changes to the topography such as fences, roads and power lines. Measurements along such lines would not be representative of marsh habitat. Therefore, longitude lines were used and transect lines were placed at 7.5° intervals beginning on Longitude 93°52'30" West and extending eastward. Coverage of the entire Louisiana coast required 39 lines. The exact location of the transect lines is shown in Table 4.

Sampling stations were placed along each transect line at 0.25 mile intervals using latitude lines as reference points. The intersection of the latitude line and the transect line were used as a reference point and the other points on the transect were extended northward at 0.25-mile intervals. In several instances the reference line selected was inland making it necessary to place sample points south of the line. The latitude line used as a reference point is shown in Table 4. This procedure was selected so that the same sampling areas could be located in future studies. Also, because of the irregular pattern of the Louisiana shoreline this method provided starting points at varying distances from the beach.

The transect lines and sampling station were located on quadrangle maps of the area having a scale of 1 inch to 1 mile. The maps were

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Table 4. The location of starting points on transect lines used for sampling

| Line No. | Longitude | Reference Point (Latitude) | Distance and Direction to Starting Pt. from Reference Pt. (miles) |
|---|---|---|---|
| 1 | 93° 47' 30" | 29° 30' | 14-N |
| 2 | 93° 40' | 29° 45' | 2-S |
| 3 | 93° 32' 30" | 29° 45' | Same |
| 4 | 93° 25' | 29° 45' | Same |
| 5 | 93° 17' 30" | 29° 45' | Same |
| 6 | 93° 10' | 29° 45' | Same |
| 7 | 93° 2' 30" | 29° 45' | 2-S |
| 8 | 92° 55' | 29° 30' | 12-N |
| 9 | 92° 48' 3-" | 29° 30' | 8-N |
| 10 | 92° 40' | 29° 30' | 6-N |
| 11 | 92° 32' 30" | 29° 30' | 4-N |
| 12 | 92° 25' | 29° 30' | 2-N |
| 13 | 92° 17' 30" | 29° 30' | 2-N |
| 14 | 92° 10' | 29° 30' | 4-N |
| 15 | 92° 2' 30" | 29° 30' | 4-N |
| 16 | 91° 55' | 29° 30' | Same |
| 17 | 91° 47' 30" | 29° 30' | 2-S |
| 18 | 91° 40' | 29° 30' | 16-N |
| 19 | 91° 32' 30" | 29° 30' | Same |
| 20 | 91° 25' | 29° 30' | Same |
| 21 | 91° 17' 30" | 29° 15' | Same |
| 22 | 91° 10' | 29° 00' | 14-N |

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Table 4. Continued

| Line No. | Longitude | Reference Point (Latitude) | Distance and Direction to Starting Pt. from Reference Pt. (miles) |
|---|---|---|---|
| 23 | 91° 2' 30" | 29° 00' | 12-N |
| 24 | 90° 55' | 29° 00' | 2-N |
| 25 | 90° 47' 30" | 29° 00' | 2-N |
| 26 | 90° 40' | 29° 00' | 2-N |
| 27 | 90° 32' 30" | 29° 00' | 14-N |
| 28 | 90° 25' | 29° 00' | 2-N |
| 29 | 90° 17' 30" | 29° 00' | 4-N |
| 30 | 90° 10' | 29° 00' | 6-N |
| 31 | 90° 2' 30" | 29° 7' 30" | 4-N |
| 32 | 89° 55' | 29° 15' | 2-N |
| 33 | 89° 47' 30" | 29° 15' | 4-N |
| 34 | 89° 40' | 29° 15' | 2-N |
| 35 | 89° 32' 30" | 29° 15' | 2-S |
| 36 | 89° 25' | 28° 45' | 12-N |
| 37 | 89° 17' 30" | 29° 00' | 2-N |
| 38 | 89° 10' | 29° 00' | Same |
| 39 | 89° 2' 30" | 29° 00' | 8-N |

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published by the U. S. Army Corps of Engineers and the U. S. Geological Survey, and proved to be very accurate.

Certain marsh areas have no surface features which can be located on a map for the purpose of aerial navigation. Test flights were made over lines having ground markers placed at 0.25-mile intervals. The exact travel time between stations was noted along with other factors such as wind direction and velocity. Under normal situations the travel time from one sampling station to the other was 18 seconds. The sampling stations were located with reasonable accuracy by using a stop watch to determine distances, the helicopter compass for navigation along transect lines, and the quadrangle maps to locate starting points and for position corrections when important surface features were present.

A sampling point on the ground was selected by throwing a marker from the helicopter at the moment it reached the station and began to hover. The markers were made by tying a 3-foot section of plastic marking tape to a 0.50-inch flat steel washer. This method reduced bias in the selection of the sampling points and provided a means whereby the same point could be located on the ground when landings were made for the purpose of ruler measurement.

Landings were made whenever possible at every eighth station or at 2-mile intervals along each transect line. The helicopter could not be landed in vegetation taller than 4 feet because of possible damage to the tail rotor. Therefore, unless an opening suitable for landing was found near the station, no landing was attempted. Also, whenever the eighth station fell in large bodies of water, landing was usually omitted except for the purpose of taking water samples. Over 400 landings were made during the sampling period (Plate 2).

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Plate 2

A helicopter landing with the delicate tail rotor placed in a small opening surrounded with *Sagittaria falcata*, *Typha* sp. and *Myrica cerifera*

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A numbering system was devised to identify individual stations whereby the station number would indicate the transect number, distance from the Gulf of Mexico and whether the sample was an aerial estimate or a ground measurement. The first two digits identified the transect line, the next two digits the 2-mile interval between landings and the last designated the 0.25-mile station within the 2-mile interval. Eight such stations occurred within the interval, and the landing was made for the vegetation measurement only at the last station. Therefore, for identification purposes number 8 was used to designate the aerial estimate at this station, and number 9 the ground measurement of the same point. As an example station 24-178 would identify a station on Transect 24 with the 17 indicating the number of 2-mile intervals completed and number 8 designating the eighth one-quarter mile station within the two-mile interval. Station 24-179 would designate a ground measurement of the previously described point.

## Vegetation Sampling

Various methods were considered for obtaining information regarding vegetation along the transect lines. The method used had to meet four basic requirements. The first requirement was that the technique demand only a minimum of time at each station. Landing was not possible at each station; therefore, the sampling procedure had to be one which would provide the desired information through estimates made at distances of 10 to 15 feet. A large number of species would be encountered during this study, thus the technique had to be one which could be used with ease on all species, ranging from *Eleocharis parvula* with a height of 1 inch to *Phragmites communis*, which is often 10 feet tall. The number

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and extent of openings in a marsh frequently indicate the direction in which the marsh is progressing. Therefore, the sampling method should provide information on the amount of non-vegetated, as well as vegetated, areas.

Three methods of sampling as described by Brown (1954) were considered for the purposes of this study. Included were the dry weight method, stem count method and the line intercept method. None of these methods was without faults and only the line intercept method could meet over two of the four basic requirements. Consequently, plans were made to use the line-intercept method with certain modifications as used by this writer during earlier studies (Chabreck, 1960).

The line-intercept method of sampling was developed by Canfield (1941) for range vegetation studies in the semi-arid regions of the Southwestern United States. For his studies small patches of bare ground occurring between clumps of vegetation were not included in the vegetation measurements, if they were large enough to accommodate additional plants. However, if in his judgement the openings were too small to admit additional plants, the space was then listed as continuous vegetation and included as part of adjacent stands.

According to Brown (1954) the principal usage of the line-intercept method is the horizontal, linear measurement of plants along a transect line. Vegetation along the line is recorded in units of length and the total length of the intercepts of certain species along the line is listed as a numerical value equaling the ground surface occupied by the species.

During this study vegetation was sampled on the ground by using a 5-foot ruler graduated into 50 units each 0.10-foot long. From a

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randomly selected sampling point the ruler was extended out in the direction of flight on the particular transect line. Plant communities and opening were then tabulated as they occurred along the ruler to the nearest 0.10-foot.

A similar procedure was followed in sampling from the air as when ground measurements were taken. However, from the helicopter a span of 5 feet was estimated beginning at the marked point and extending in the direction of travel. This area was observed very carefully to determine the ratio of vegetated areas and openings. Then the vegetated area was checked for estimates of the species composition. Using the same basis of 50 units, the distance occupied by each species was listed to the nearest 0.10-foot and the remainder as non-vegetated.

The area sampled covered a minute portion of the area and the chances of encountering all species in the area were unlikely. Therefore, all plants observed within 100 feet of the sample point were listed on the tally sheet. Then, based on the plants present, the marsh at each sample station was classified as saline, brackish, nearly fresh (intermediate) or fresh as described by Penfound and Hathaway (1938).

## Soil and Water Sampling

Soil and water samples were taken at 2-mile intervals along the transects where landings were possible. Also, extra samples were taken in special areas not included by the routine landings. Soil samples were taken at a depth extending from the surface to 12 inches. This depth included the root zone for practically all marsh plants in the coastal area. Water samples were taken from free soil water and like

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soil samples, additional water samples were taken where needed at locations other than the regular stops.

Approximately 1 quart of soil was collected from each station and placed in a plastic bag (Plate 3). The plastic bag was then placed inside a cloth bag to minimize the danger of accidental breakage. Water samples were collected and transported in one-ounce glass jars. The station number was written on the bag for identification and the samples stored in refrigeration at 30°F. during the interval between collection and drying.

## Vegetation Data Analysis

The coastal area was classified for descriptive purposes on a basis of marsh zones and vegetative types.

### Marsh Zones

The first classification, marsh zones, was further subdivided into Chenier Plain Marsh, Inactive Delta Marsh and Active Delta Marsh as described by O'Neil (1949) and shown in Figure 1. He used the term Sub-delta Marshes in describing the marshes built by earlier Mississippi River Deltas, but during this study the name Inactive Delta Marshes was used for this zone. The zones varied in either origin or age and comparisons were made in the vegetation and soil chemistry of the area.

### Vegetative Types

The vegetative types as described by Penfound and Hathaway (1938) were used as a means of marsh classification. These investigators determined the relative salt tolerance of the major vascular plants along the Louisiana coast, and grouped them as strictly fresh water

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Plate 3

Collecting a soil sample in *Spartina patens* marsh for chemical analysis

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species, nearly fresh water species, brackish water species and salt water species. Using their system of classification each sampling station falling in marsh was listed as fresh marsh, intermediate marsh, brackish marsh or salt marsh on the basis of the plants present. The term, intermediate marsh, was first used by O'Neil (1949) in describing marsh, which included the nearly fresh water species.

The use of this system is not to imply that the plants follow rigid rules, and the presence of certain species indicates a particular vegetative type. Instead, a number of species had such wide salinity tolerance that they appeared in as many as three vegetative types. Only a few species had limited ranges and could be considered indicator plants for a particular type. However, these species were so few that in most situations an indicator was not present at a particular sampling point. Therefore, rather than using individual species, plant associations provided the best scheme of classification. The following is a listing of the common plants used in identifying the various vegetative types. The boundaries of vegetative types are shown on the map by Chabreck, Joanen and Palmisano (1965).

Saline Marsh. The saline marsh is situated either adjacent to the Gulf of Mexico or around the edge of lakes and bays near the Gulf having highly saline waters. Typical vegetation are combinations of the following: *Spartina alterniflora*, *Juncus roemerianus*, *Batis maritima*, *Avicennia nitida* and *Distichlis spicata*.

Brackish Marsh. This is marsh of moderate salinity generally lying inland from the saline marshes or around the borders of bays and tidal lakes with moderate salinity. Marshes were classified as brackish when various combinations of the following species occurred: *Spartina*

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patens, Scirpus olneyi, Scirpus robustus, Eleocharis parvula, and Ruppia maritima.

Intermediate Marsh. Intermediate marsh is that with low salinity and characterized by combinations of the following plants: Spartina patens, Vigna repens, Scirpus californicus, Echinochloa walteri, Sagittaria sp., Cladium jamaicense and Phragmites communis. The intermediate marsh generally appears as a narrow band separating a brackish marsh from a fresh marsh and supports a wide variety of plant species (O'Neil, 1949).

Fresh Marsh. The fresh marsh lies farther inland than the other marsh types and is not influenced by tidal action. Typical plant associations include combinations of the following: Panicum hemitomon, Hydrocotyle sp., Eichornia crassipes, Pontederia cordata, Sagittaria sp., Alternanthera philoxeroides and Ceratophyllum demersum.

The brackish marsh frequently included species listed in the saline marsh and intermediate marsh. Likewise, the intermediate marsh often contained species typical of the brackish and fresh marsh. In fact it was not unusual to have a brackish marsh with none of the species listed. Instead, the vegetation may consist of a combination of saline and intermediate marsh species. Also, intermediate marsh may have been made up entirely of a combination of brackish and fresh marsh species.

## Soil Analysis

A total of 391 soil samples were collected in the coastal area for chemical analysis. Prior to the analysis each sample was weighed, air dried, then reweighed to determine the moisture content. The

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samples were dried at normal air temperature, and because of an extremely high moisture content, drying required several weeks.

The dried samples were analyzed by the Louisiana Soils Testing Laboratory at Louisiana State University. Tests included in the analysis were those for total salts and carbon. The analytical methods used are described in a bulletin by Brupbacker, Bonner and Sedberry (1968). A summary of the procedure listed in that publication is as follows.

Soluble salts refer to the inorganic components of the soil that are soluble in water. The standard gravimetric method was used and the measurements determined the salt concentration of specific soil-water extracts. A 50 gram sample of soil was mixed with 125 ml of distilled water and allowed to remain overnight The mixture was then filtered through a Pasteur-Chamberlain filter. A 50 ml. aliquot of the filtrate was then placed in an evaporating dish of known weight and dried in an oven. The residue was then ignited with a Fisher Burner at a low temperature to remove the organic matter. The weight of the remaining residue is the weight of the total soluble salts from 20 grams of soil.

Organic carbon in the soils was determined by the dry combustion method described by Allison, Bollen, and Moodie (1965). A 0.15 gram sample of soil was transferred to a ceramic boat and placed in a combustion tube which had been preheated to 950°C. Purified oxygen was passed through the system in the presence of a platinum catalyst to convert the carbon evolved from the soil sample to carbon dioxide. The carbon dioxide gas was absorbed in preweighed pyrex glass bulbs

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containing ascarite. After evolution of the carbon dioxide the glass bulbs were again weighed and the weight of the $CO_2$ determined.

The percentage organic matter was computed from the information on organic carbon. The method as described by Wilson and Stoker (1932) for peat soils simply involves multiplying the percentage of organic carbon by the factor 1.724.

## Water Salinity Analysis

Water salinity was determined using a Model RC-16B1 Conductivity Bridge manufactured by Industrial Instruments, Incorporated. This instrument was actually designed for the measurement of solution resistance. The determination of conductivity consisted of a measurement of the resistance of the solution to electrical current flow (McNease, 1964). A dip cell containing two electrodes was placed in a column of solution, and the resistance of the solution to electrical current flow appeared on the instrument dial. The resistance indicated was the reciprocal of the solution conductivity. The dip cell employed for this study was a Model CEL-k1 having a cell constant of 1.0. This particular dip cell was very small and could be used for testing small quantities of solution. The jars used for collecting water samples had a capacity of 1 ounce.

Samples were held in the lab overnight prior to testing, so that the water temperature would remain constant during analysis. The temperature of each sample was taken and a correction factor obtained from a table by Richards (1954). The resistance reading was corrected with the temperature factor and converted to electrical conductivity by mathematical computation. The value of the adjusted

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conductivity was then located on a prepared table and the salinity read from the table in parts per thousand.

## Measurement of Changes in Vegetative Types

Retreats and advances of vegetative types were determined by measuring the width of the types on maps of the coastal marshes. A vegetative type map was published by O'Neil (1949) showing plant types in the period from 1941 to 1945. Another type map, prepared by Chabreck, Joanen and Palmisano (1968) as a segment of the present study, was used as a comparison.

The measurements were taken along 10 of the transect lines used for sampling. The width of each type was scaled to the nearest 0.02 inch, beginning at the shoreline of the State and extending northward to the northern boundary of the type. The saline and brackish types were the only ones included for determining the amount of retreat or advancement. The fresh and intermediate types were omitted, because slight differences in the method of classification between the two maps made comparison difficult.

## Computing Acreages

The acreages within the various subdivisions of the Louisiana Coastal Marshes were computed from the map of the area by Chabreck, Joanen and Palmisano (1968). The map outlines the boundaries of the areas, and for computation the map was then cut into smaller subdivisions representing the three marsh zones and four vegetative types within each marsh zone. Each portion was weighed on a Mettler balance, Model B-5 to the nearest 0.10 milligram.

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Differences in the weight of the individual pieces of the map were assumed to reflect differences in size, with the size indicating the area included by each portion of the map. In order to relate the weight of the paper to acreage included, nine squares of equal size were cut from the remaining part of the map. The squares were 5 inches by 5 inches and included 900 square miles or 576,000 acres.

Each square was carefully weighed on the same balance and the mean computed. The mean weight of the 9 squares was 1.6039 grams and each gram of paper included 359,124 acres on the average. On this basis it was possible to calculate the area included by individual portions of the map.

## Comparison of Sampling Methods

The line-intercept method is widely used in vegetation sampling; however, the method does not have an area basis, and density information is lacking. Nevertheless, the method does provide information on the species composition and vegetative coverage. Two other methods, dry weight of clipped plots and stem counts, are frequently used in botanical studies, but for the purposes of this study would have been too time consuming. Also, these methods do not provide information on cover.

A special study was set up to compare the results obtained by the three techniques, since all methods are commonly used in vegetation sampling. The species composition of a particular area can be determined by all three methods. Therefore, for the purpose of comparison the sampling study was made using each method to sample

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the same area. Three vegetative types (fresh, brackish and saline) were sampled and ten observations were made in each type.

Sampling points were spaced at predetermined intervals within each type. A 5-foot rules was used to measure the vegetation at each point by the line-intercept method described earlier. A quadrat 5 feet long by 0.4 foot wide was then placed over the ruler, so that the ruler marked the center of the quadrat. The number of stems of each species enclosed by the quadrat was counted, and all vegetation was clipped, separated by species, over-dried and weighed.

Regression analysis as described by Li (1964) was run on the data to determine the linear relation between the line-intercept method and the other methods tested.

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## RESULTS AND DISCUSSION

### Size of Vegetative Types and Marsh Zones

The area of the entire coastal marsh and its various subdivisions was computed from a map of the area by Chabreck, Joanen and Palmisano (1968). The acreages are presented in Table 5 and show that the entire Louisiana Coastal Marshes include some 4.2 million acres. This figure includes small water bodies associated with the marsh; however, large lakes, bays and other non-marsh areas were excluded. Similar measurements by Barrett (1969) and Eichhorn and Guice (1969) of the same map reported that the Louisiana Coastal Marshes contained about 3.9 million acres, a difference of only 8 percent from this study. Barrett (1969) computed the following acreages in regard to the area of the different vegetative types: saline marsh (862,973 acres), brackish marsh (1,203,790 acres), intermediate marsh (620,576 acres) and fresh marsh (1,193,325 acres). The Barrett (1969) and Eichhorn and Guice (1969) measurements were made with a polar planimeter and all compared very closely with this study, lending support to the accuracy.

The area of different marsh zones as reported by Eichhorn and Guice (1969) listed the Chenier Plain Marsh Zone as 1,071,519 acres, Inactive Delta as 2,520,093 acres and the Active Delta as 266,470 acres. O'Neil (1949) reported that the coastal marshes contained 4 million acres. Further breakdowns by O'Neil (1949) showed the Chenier Plain Zone with 760,000 acres, the Inactive Delta Zone with



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Table 5. The acreage of marsh zones and vegetative types in the Louisiana Coastal Marshes, August, 1968

| Marsh Zones | Vegetative Types | | | | |
|---|---|---|---|---|---|
| | Saline | Brackish | Intermediate | Fresh | Total |
| | - - - - - - - - - Thousands of Acres - - - - - - - - - | | | | |
| Chenier Plain | 47.3 | 364.9 | 354.6 | 425.1 | 1,191.9 |
| Sub-delta | 868.5 | 907.0 | 224.9 | 744.9 | 2,745.3 |
| Active Delta | 15.6 | 23.1 | 106.8 | 129.4 | 274.9 |
| Total | 931.4 | 1,295.0 | 686.3 | 1,299.4 | 4,212.1 |

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2,940,000 acres and the Active Delta Zone with 300,000 acres. Comparing these figures with Table 5 shows a slight acreage reduction on the Deltaic Plain during the time interval between studies. However, the size of the Chenier Plain has appeared to increase over the years. The validity of this comparison is in doubt, since O'Neil (1949) did not indicate the method used to compute acreages and did not specify the physiographic features included.

Measurement of the different marsh zones (Table 5) revealed that in 1968 the Sub-delta Marsh made up almost two-thirds of the coastal marsh. The Chenier Plain comprised 28.3 percent of the total marsh and the Active Delta contributed only 6.5 percent.

In regard to vegetative types the fresh and brackish types were very similar in size, making up 30.8 and 30.7 percent of the entire marsh, respectively. The saline type comprised less than one-fourth of the total area, and the intermediate made up only 16.4 percent.

Fresh marsh was the major type in both the Chenier Plain and Active Delta Marsh Zones. In the Inactive Delta the brackish type was the largest vegetative type. Saline marsh was almost insignificant in the Chenier Plain and Active Delta, comprising only about 5 percent of each zone; however, in the Inactive Delta the saline type made up 20.6 percent of the total marsh.

## Changes in Vegetative Types and Marsh Zones

Changes in the location of the saline and brackish vegetative types were determined by comparing the vegetative type map by O'Neil (1949) with that by Chabreck, Joanen and Palmisano (1968). The map by

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O'Neil covers the period from 1941 to 1945 and the other shows the location of vegetative types in 1968, a difference of about 25 years.

Saline marsh in Southwestern Louisiana occupied a narrow strip about 0.5 mile wide adjacent to the Gulf of Mexico. The 1968 maps showed no noticeable change in the width of the type during the period. The Inactive Delta Marsh Zone showed a different situation. Measurements from the earlier map revealed that the saline zone extended inland for an average of 5.8 miles, while the 1968 map placed this type 7.9 miles inland, an encroachment averaging 2.1 miles in the Inactive Delta Marshes.

The brackish marsh type, which bordered the saline marsh, was also compared on the two maps. The lines measured revealed that the brackish marsh extended inland an average of 9.0 miles during the 1941-45 period and 9.7 miles in 1968, a retreat of only 0.7 miles. However, considerable differences were noted between the Chenier Plain and Inactive Delta Marshes. The earlier map shows the Inactive Delta brackish marshes extending inland for an average of 12.4 miles; but, in 1968, the northern boundary of this type was 16.2 miles inland. In contrast, the brackish type of the Chenier Plain extended inland for a mean distance of 5.6 miles during the O'Neil study, but by 1968 the northern boundary of this type had advanced southward to a line only 3.2 miles inland.

Since the saline vegetative type maintained essentially the same position over the years in the Chenier Plain Marsh Zone, the seaward advancement of the northern boundary of the brackish type represents a reduction in the width of this type. In fact, O'Neil

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(1949) shows the Chenier Plain brackish type as a strip 5.1 miles wide, while Chabreck, Joanen and Palmisano (1968) show this same type 2.6 miles wide, a reduction of about 47 percent. The brackish type in the Inactive Delta Marshes actually widened during the 25-year period. During the earlier period, this type was 6.6 miles wide, but by 1968, the average width had increased to 8.3 miles.

The widening of the saline and bfackish vegetative types in the Inactive Delta Marsh Zone resulted from salt-water intrusion from the Gulf of Mexico into the intermediate and fresh vegetative types. Increased canal dredging and stream channelization were major factors in the change.

The reduction in the width of the brackish type on the Chenier Plain reflects a reduction in water salinities in that area. Factors operating to reduce water salinities during the 25-year interval included: the Wax Lake Outlet, Mermentau Basin Reservoir, and marsh management practices on wildlife refuges in the area. The Wax Lake Outlet resulted in the discharge of large amounts of Atchafalaya River water into Vermilion Bay, thus reducing water salinities in that area. The Mermentau Basin was developed as a freshwater reservoir for rice irrigation and included a large portion of the eastern half of the Chenier Plain Marsh Zone. Special development projects on Rockefeller Wildlife Refuge and Sabine National Wildlife Refuge served as a partial barrier to salt water, thus reducing water salinities over large areas.

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## Plant Species Composition

The 39 transect lines sampled during this study included a wide range of marsh conditions and plant species. A total of 118 species of vascular plants occurred at the sampling points, and the species composition of different areas varied considerably. Reference specimens were placed in the Louisiana State University Herbarium.

Most earlier studies on marsh vegetation along the Louisiana coast simply listed the species present, and none of these studies included quantitative sampling along the entire coast. Although the method of classifying vegetative types used during this study was based on the plant associations listed by Penfound and Hathaway (1938), their work was limited to the Inactive Delta Marsh Zone and they reported only the relative abundance of species within individual vegetative types.

The literature contains numerous reports of the vegetation within specific areas along the Louisiana coast. Only the report by O'Neil (1949) mentioned the vegetation on a coastwide basis by marsh zones and vegetative types. Although that study did not involve quantitative measurements, the author presented a vegetative type map of the Louisiana coast showing the boundary and dominant species of major plant communities. Numerous other studies of a local nature have recorded the vegetation for specific areas within the Louisiana Coastal Marshes. The major plant species as listed by these studies are shown by vegetative type within the Chenier Plain (Table 6), Inactive Delta (Table 7) and Active Delta (Table 8).

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Table 6. Published reports of major plant species of vegetative types within the Chenier Plain Marsh Zone

| Species | Saline | Brackish | Intermediate | Fresh |
|---|---|---|---|---|
| | Vegetative Types | | | |
| *Alternanthera philoxeroides* | | | | a,i |
| *Batis maritima* | a | | | |
| *Borrichia frutescens* | a,c | | | |
| *Cladium jamaicense* | | | g | e |
| *Distichlis spicata* | a,c,f,g | a,c,h | | |
| *Juncus roemerianus* | | g | | |
| *Panicum hemitomon* | | | | a,g |
| *Paspalum vaginatum* | | | a | |
| *Phragmites communis* | | | e,f | c,f |
| *Ruppia maritima* | | a,b,d | | |
| *Sagittaria falcata* | | | a,b | a,c,d,g,i |
| *Scirpus californicus* | | | | c,d |
| *Scirpus olneyi* | | a,c,g | | |
| *Scirpus robustus* | a | g | | |
| *Spartina alterniflora* | a,g | c | | |
| *Spartina cynosuroides* | f | c,g | e | |
| *Spartina patens* | | a,b,c,d,e,f,g,h | a,b,c,e | a |

Sources of information:

(a) This report (Tables 11, 12, 13, and 14)
(b) Chabreck (1960)
(c) Chamberlain (1957)
(d) Fogarty (1965)
(e) Harris and Webert (1962)
(f) Nichols (1959)
(g) O'Neil (1949)
(h) Reese (1961)
(i) Valentine (1964)

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Table 7. Published reports of major plant species of vegetative types within the Inactive Delta Marsh Zone

| Species | Vegetative Types | | | |
|---|---|---|---|---|
| | Saline | Brackish | Intermediate | Fresh |
| Alternanthera philoxeroides | | | | d,h |
| Avicennia nitida | b,g,j | | | |
| Cladium jamaicense | | | h,j | d,h |
| Distichlis spicata | a,b,g,h,j | a,f,i,j | | |
| Juncus roemerianus | a,b,d,g,h,j | a,c,i,j | | |
| Panicum hemitomon | | | | a,d,h |
| Sagittaria falcata | | | a | a,j |
| Scirpus californicus | | | j | h,j |
| Scirpus olneyi | | c,e,f,g,h,i | | |
| Spartina alterniflora | a,d,g,h,j | | | |
| Spartina cynosuroides | | f,i,j | a | |
| Spartina patens | a,b,d,h | a,c,e,f,g,h,i,j | | |
| Typha latifolia | | | | d,h,j |
| Vigna repens | | g | a | |

Sources of information:

(a) This report (Tables 11, 12, 13, and 14)
(b) Brown (1936)
(c) Chabreck and Hoffpauir (1962)
(d) Eggler (1961)
(e) Harris and Chabreck (1958)
(f) Harris and Webert (1962)
(g) Lemaire (1961)
(h) O'Neil (1949)
(i) Orton (1959)
(j) Penfound and Hathaway (1938)

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Table 8. Published reports of major plant species of vegetative types within the Active Delta Marsh Zone

| Species | Vegetative Types | | |
| --- | --- | --- | --- |
| | Brackish | Intermediate | Fresh |
| *Alternanthera philoxeroides* | | | a,c,d |
| *Bacopa monnieri* | | a | |
| *Ceratophyllum demersum* | | | d |
| *Distichlis spicata* | a,c,d | | |
| *Eichornia crassipes* | | | a,d |
| *Juncus roemerianus* | d | | |
| *Lemna minor* | | | a,c |
| *Myriophyllum spicatum* | | | a |
| *Panicum repens* | | a | |
| *Phragmites communis* | a,d | a,b,c,d | a,b,c,d |
| *Scirpus americanus* | | c,d | |
| *Scirpus robustus* | a | | |
| *Spartina alterniflora* | a,c,d | a,c,d | |
| *Typha latifolia* | | c | c,d |

Reported by:

(a) This report (Tables 12, 13, and 14).
(b) Brown (1936)
(c) Lloyd and Tracy (1901)
(d) O'Neil (1949)

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Chamberlain (1957) classified the Chenier Plain marsh as salt, brackish or fresh during studies on Rockefeller Refuge. He listed the major plant species associated with each type and cited figures on relative abundance. Nichols (1959) conducted a geological survey of the same area and listed the dominant plants at various locations. Chabreck (1960) sampled transects on this area and compared the species composition of plants within impoundments with the composition of adjacent natural marshes.

Other vegetation studies on the Chenier Plain include the survey by Reese (1961) in the marshes west of Vermilion Bay. Under the division Spermatophyta he reported 49 families, 97 genera and 104 species. Harris and Webert (1962) established marsh transects during studies on nutria, Myocastor coypus, feeding activity and reported the major plant species within each study area. The transects were placed in intermediate and fresh types.

Valentine (1964) used the line-intercept method to sample vegetation on Laccassine National Wildlife Refuge. Transects were established in a fresh marsh and sampled annually over a period of 7 years. He reported 45 genera and 41 species during the study. Fogarty (1965) sampled the marsh west of Calcasieu Lake by the same method and reported the species composition of fresh and brackish marsh in the area.

Brown (1936) listed the common marsh plants in the vicinity of Indian mounds and middens in the Inactive Delta Marshes of Plaquemines and St. Bernard Parishes. He also made brief mention of the vegetation in the Active Delta as observed while traveling through that zone.

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Penfound and Hathaway (1938) studied the vegetation of the Inactive Delta in the vicinity of New Orleans and devised the method of classifying vegetative types as used during this study. They listed the species occurring in each vegetative type and gave the salinity range of each species.

Other reports on marsh vegetation in the Inactive Delta include the studies on Marsh Island by Harris and Chabreck (1958), Orton (1959), Chabreck and Hoffpauir (1962), and Harris and Webert (1962). Harris and Chabreck (1958) remeasured transects established prior to Hurricane Audrey to determine changes in the marsh associated with the hurricane. Orton (1959) conducted a geological study of the island and listed the major plant species at various locations. Chabreck and Hoffpauir (1962) studied the effects of weirs on Marsh Island and sampled the vegetation in various sections of the island. Vegetation measurements were also made on Marsh Island by Harris and Webert (1962) in conjunction with nutria studies. Both studies established transects which were sampled annually to measure changes in marsh vegetation.

Lemaire (1961) conducted a detailed survey of vascular plants in St. Bernard Parish and reported 280 species from 85 families and 212 genera. A study by Eggler (1961) listed the plants of the Grand Bayou Blue drainage basin in Lafourche Parish. Both studies were in the Inactive Delta and provided information on relative abundance.

The literature contains very little information on vegetation of the Active Delta Zone. In addition to the observations by Brown (1936) and O'Neil (1949), studies by Lloyd and Tracy (1901) are of historical

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importance and list the species found in that area. Even at the end of the 19th century man's influence was evident. The authors reported a number of exotic plant species, which they believed were introduced from ballast tanks emptied upon entering the Mississippi River. However, two exotics listed as major species during this study, Eichornia crassipes and Myriophyllum spicatum, were not reported by Lloyd and Tracy (1901).

The following is a discussion of the species composition of the entire coastal marsh, and also marsh zones and vegetative types within the coastal area, as occurred in August, 1968. For descriptive purposes, plant species making up over 5 percent of the species composition were considered to be major species. Those comprising between 2 and 5 percent were listed as secondary in occurrence and those from 1 to 2 percent were classified as minor species. Species composing less than 1 percent of the species composition were considered uncommon.

Species Composition of the Entire Coastal Marsh

Only five species were present in amounts large enough to individually comprise more than 5 percent of the vegetative composition of the Louisiana Coastal Marshes. These five species of 118 species occurring at the sampling points made up almost 60 percent of the marsh vegetation. Four of the five species were grasses.

The major species along the Louisiana coast, as shown in Table 9, was Spartina patens. This species made up 24.58 percent of the vegetative composition and almost doubled the values for its nearest competitor, Spartina alterniflora. The number three plant was Panicum

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Table 9. Plant species composition of marsh zones in the Louisiana Coastal Marsh, August, 1968

| Species | Marsh Zones: Chenier Plain | Marsh Zones: Inactive Delta | Marsh Zones: Active Delta | Entire Marsh |
|---|---|---|---|---|
| | Percent | | | |
| *Acnida alabamensis* | .14 | .06 | -- | .08 |
| *Aeschynomene virginica* | -- | .05 | -- | .02 |
| *Alternanthera philoxeroides* | 5.22 | .82 | 5.31 | 2.31 |
| *Aster* sp. | -- | .21 | -- | .14 |
| *Avicennia nitida* | -- | .16 | -- | .11 |
| *Azolla caroliniana* | -- | .07 | -- | .05 |
| *Baccharis halimifolia* | .10 | .13 | -- | .12 |
| *Bacopa caroliniana* | .51 | .03 | -- | .17 |
| *Bacopa monnieri* | 1.98 | 1.16 | 3.71 | 1.52 |
| *Bacopa rotundifolia* | .28 | -- | -- | .08 |
| *Batis maritima* | .20 | 1.09 | -- | .78 |
| *Bidens laevis* | -- | .05 | -- | .03 |
| *Borrichia frutescens* | .28 | .11 | -- | .15 |
| *Brasenia schreberi* | .83 | -- | -- | .24 |
| *Caboma caroliniana* | .89 | -- | -- | .26 |
| *Carex* sp. | -- | .01 | -- | .01 |
| *Centella erecta* | .04 | .08 | -- | .07 |
| *Cephalanthus occidentalis* | .22 | .02 | -- | .08 |
| *Ceratophyllum demersum* | .53 | .59 | -- | .55 |
| *Cladium jamaicense* | .02 | .45 | -- | .31 |
| *Colocasia antiquorum* | -- | .21 | -- | .14 |
| *Cuscuta indecora* | -- | .01 | -- | .01 |

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Table 9. Continued

| Species | Marsh Zones: Chenier Plain | Inactive Delta | Active Delta | Entire Marsh |
|---|---|---|---|---|
| | - - - - - - - - Percent - - - - - - - - | | | |
| *Cynodon dactylon* | .12 | -- | -- | .04 |
| *Cyperus compressus* | -- | .01 | -- | .01 |
| *Cyperus odoratus* | 1.24 | 1.18 | .16 | 1.15 |
| *Daubentonia texana* | .24 | -- | -- | .07 |
| *Decodon verticillatus* | -- | .28 | -- | .19 |
| *Dichromena colorata* | -- | .02 | -- | .01 |
| *Distichlis spicata* | 6.73 | 7.16 | 1.19 | 6.77 |
| *Dryopteris thelypteris* var. *haliana* | -- | .24 | -- | .16 |
| *Echinochloa walteri* | 1.58 | .46 | .53 | .79 |
| *Eichornia crassipes* | .04 | .58 | 2.80 | .52 |
| *Eleocharis parvula* | .76 | 1.18 | .53 | 1.03 |
| *Eleocharis* sp. | 2.27 | 5.94 | 1.11 | 4.65 |
| *Eupatorium capillofolium* | -- | .02 | -- | .02 |
| *Eupatorium* sp. | .02 | .03 | -- | .02 |
| *Fimbristylis castanea* | .10 | .05 | -- | .06 |
| *Gerardia maritima* | .08 | Tr. | -- | .03 |
| *Heliotropium curassavicum* | -- | .01 | -- | .01 |
| *Hibiscus lasiocarpus* | .03 | .03 | -- | .03 |
| *Hydrocotyle bonariensis* | -- | .01 | -- | .01 |
| *Hydrocotyle ranunculoides* | -- | .06 | -- | .04 |
| *Hydrocotyle umbellata* | .23 | .96 | -- | .70 |

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Table 9. Continued

| Species | Marsh Zones | | | Entire Marsh |
|---|---|---|---|---|
| | Chenier Plain | Inactive Delta | Active Delta | |
| | - - - - - - - - Percent - - - - - - - - | | | |
| Hymenocallis occidentalis | .17 | .01 | -- | .06 |
| Hypericum virginicum | -- | .04 | -- | .02 |
| Ipomoea stolonifera | -- | .02 | -- | .01 |
| Ipomoea sagittata | .37 | .19 | -- | .24 |
| Iva frutescens | -- | .06 | -- | .04 |
| Juncus effusus | .08 | .03 | -- | .04 |
| Juncus roemerianus | 1.33 | 4.45 | -- | 3.34 |
| Jussiaea alterniflora | .04 | .11 | -- | .09 |
| Jussiaea uruguayensis | .57 | .21 | -- | .31 |
| Kosteletzkya virginica | -- | .09 | -- | .06 |
| Lemna minor | .10 | 1.00 | 3.95 | .87 |
| Leptochloa fascicularis | .88 | .52 | -- | .60 |
| Leptochloa filiformis | .02 | -- | -- | .01 |
| Limnobium spongia | .01 | .08 | -- | .06 |
| Lippia nodiflora | -- | .03 | -- | .02 |
| Lycium carolinianum | .04 | -- | -- | .01 |
| Lythrum lineare | .02 | .14 | -- | .10 |
| Myrica cerifera | -- | .09 | -- | .06 |
| Myriophyllum spicatum | -- | .07 | 14.19 | .68 |
| Myriophyllum heterophyllum | .24 | -- | -- | .07 |
| Najas guadalupensis | 1.47 | .17 | -- | .54 |
| Nelumbo lutea | .59 | .03 | -- | .20 |

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Table 9. Continued

| Species | Marsh Zones: Chenier Plain | Inactive Delta | Active Delta | Entire Marsh |
|---|---|---|---|---|
| | - - - - - - - - - Percent | - - - - - - - - - | | |
| *Nymphaceae odorata/tuberosa* | 1.43 | -- | -- | .42 |
| *Nymphoides aquaticum* | .14 | -- | -- | .04 |
| *Osmunda regalis* | -- | .27 | -- | .18 |
| *Ottelia alismoides* | .04 | -- | -- | .01 |
| *Panicum hemitomon* | 5.82 | 11.60 | 1.06 | 9.44 |
| *Panicum repens* | -- | -- | 5.04 | .22 |
| *Panicum virgatum* | .69 | .57 | -- | .58 |
| *Panicum* sp. | -- | .05 | -- | .04 |
| *Paspalum dissectum* | .73 | -- | .27 | .21 |
| *Paspalam vaginatum* | 3.38 | .35 | -- | 1.22 |
| *Philoxerus vermicularis* | .02 | -- | -- | .02 |
| *Phragmites communis* | .99 | .18 | 35.86 | 2.01 |
| *Pluchea foetida* | -- | .01 | -- | .01 |
| *Pluchea camphorata* | .52 | .83 | .77 | .74 |
| *Polygonum* sp. | .04 | .29 | -- | .20 |
| *Pontederia cordata* | .03 | .03 | -- | .03 |
| *Potamogeton nodosus* | .18 | -- | -- | .05 |
| *Potamogeton pusillus* | .38 | .09 | 1.99 | .26 |
| *Ruppia maritima* | 2.26 | .90 | .53 | 1.28 |
| *Sacciolepsis striata* | .08 | -- | -- | .02 |
| *Sagittaria falcata* | 11.52 | 4.59 | 1.46 | 6.47 |
| *Sagittaria latifolia* | -- | .12 | -- | .08 |
| *Sagittaria platyphylla* | -- | -- | 1.86 | .08 |

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Table 9. Continued

| Species | Marsh Zones: Chenier Plain | Inactive Delta | Active Delta | Entire Marsh |
|---|---|---|---|---|
| | - - - - - - - - - Percent- | - - - - - - - - | | |
| Sagittaria sp. | -- | .02 | -- | .01 |
| Salicornia bigelovii | .04 | .02 | -- | .02 |
| Salicornia virginica | -- | .17 | -- | .11 |
| Salix nigra | .08 | -- | -- | .02 |
| Saururus cernuus | -- | .02 | 1.06 | .06 |
| Scirpus americanus | .61 | -- | 1.33 | .24 |
| Scirpus californicus | 1.23 | .10 | -- | .43 |
| Scirpus olneyi | 2.63 | 2.12 | .13 | 2.19 |
| Scirpus robustus | 1.37 | .48 | 1.06 | .77 |
| Scirpus validus | -- | -- | .53 | .02 |
| Sesbania exaltata | .13 | .02 | -- | .05 |
| Sesuvium portulacastrum | .04 | -- | -- | .01 |
| Setaria glauca | .02 | .02 | -- | .02 |
| Setaria magna | -- | .02 | -- | .01 |
| Solidago sp. | -- | .04 | .13 | .03 |
| Spartina alterniflora | .81 | 18.03 | 10.37 | 12.66 |
| Spartina cynosuroides | .24 | .58 | .05 | .46 |
| Spartina patens | 30.74 | 23.42 | 1.46 | 24.58 |
| Spartina spartineae | .80 | -- | -- | .23 |
| Spirodela polyrhiza | -- | .02 | 1.35 | .07 |
| Suaeda linearis | -- | .06 | -- | .04 |
| Taraxacum officinale | -- | .01 | -- | (a) |

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Table 9. Continued

| Species | Marsh Zones: Chenier Plain | Inactive Delta | Active Delta | Entire Marsh |
|---|---|---|---|---|
| | - - - - - - - - Percent | - - - - - - - - | | |
| Taxodium distichum | -- | .01 | -- | .01 |
| Typha spp. | .08 | 1.03 | .21 | .72 |
| Utricularia cornuta | 1.80 | .13 | -- | .61 |
| Utricularia subulata | .26 | -- | -- | .08 |
| Vallisneria americana | -- | .03 | -- | .02 |
| Vigna repens | .24 | 2.10 | -- | 1.47 |
| Woodwardia virginica | -- | .15 | -- | .10 |
| Zizaniopsis miliacea | .02 | .65 | -- | .44 |

[a]Less than .01 percent

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hemitomon with 9.44 percent, followed by Distichlis spicata and Sagittaria falcata, the only non-grass species in the top five.

Species of secondary ranking (2 to 5 percent) were Eleocharis sp., Juncus roemerianus, Alternanthera philoxeroides and Scirpus olneyi. Of the remaining 109 species only seven made up more than 1 percent of the species composition.

Species Composition of Marsh Zones

The marsh zones along the Louisiana coast vary with age and origin. These affect other factors such as water levels and soil and water chemistry, which in turn influence the plant species composition. The marsh zones included in this study were Chenier Plain, Inactive Delta and Active Delta (Figure 1).

Chenier Plain Marsh Zone. The study included 77 plant species in the Chenier Plain Marsh of Southwestern Louisiana. The dominant species was Spartina patens, accounting for over 30 percent of the vegetation in that area. Other major species as shown in Table 9 were Sagittaria falcata, Distichlis spicata, Panicum hemitomon and Alternanthera philoxeroides. Of the remaining 72 species, four were of secondary abundance, nine were considered minor species and 59 species comprised less than 1 percent of vegetation individually.

Inactive Delta Marsh Zone. Spartina patens was also the leading species in the Inactive Delta Zone. Spartina alterniflora ranked second in the Inactive Delta Zone with 18 percent; however, this species made up less than 1 percent of the vegetation in the Chenier Plain Zone (Table 9). Other species making up more than 5 percent of the plant composition were Panicum hemitomon, Distichlis apicata and

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Eleocharis sp. Four species listed as secondary species were: Sagittaria falcata, Juncus roemerianus, Scirpus olneyi and Vigna repens. Of the remaining 87 species, five were classified in the minor group. The Inactive Delta Marsh transects contained 95 species, giving this zone a much greater number than the other two zones in total number of species at the sample points.

Active Delta Marsh Zone. The Active Delta included only 30 species at the points sampled; consequently, composition values for the individual species tended to be larger. The dominant species in this area was Phragmites communis (Plate 4), comprising 35.8 percent of vegetative composition. Other species making up more than 5 percent of the vegetation were Myriophyllum spicatum, Spartina alterniflora, Alternanthera philoxeroides and Panicum repens. Secondary species in this zone were Lemna minor, Eichornia crassipes and Bacopa monnieri. Of the remaining species 11 were rated as minor species and only 11 occurred at values less than 1 percent (Table 9).

## Species Composition of Vegetative Types

Plant species occupying a particular marsh area vary with environmental conditions; therefore, plant species composition was determined for the individual vegetative types in the Louisiana Coastal Marshes. The vegetative types, in general, lie parallel to the coast and extend inland, beginning with the saline type, and followed by the brackish, intermediate and fresh types (Chabreck, Joanen and Palmisano, 1968).

Saline Vegetative Type. The saline vegetative type had the least number of vascular plants and during this study only 17 species were recorded in this type (Table 10). Spartina alterniflora was the

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Plate 4

*Phragmites communis* surrounding an abandoned lighthouse in the Active Delta

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Table 10. Plant species composition of vegetative types in the Louisiana Coastal Marsh, August, 1968

| Species | Vegetative Types | | | |
|---|---|---|---|---|
| | Saline | Brackish | Intermediate | Fresh |
| | - - - - - - -Percent- - - - - - - - - | | | |
| Acnida alabamensis | -- | .10 | .30 | .02 |
| Aeschynomene virginica | -- | -- | -- | .07 |
| Alternanthera philoxeroides | -- | -- | 2.47 | 5.34 |
| Aster sp. | -- | .08 | .44 | .13 |
| Avicennia nitida | .60 | -- | -- | -- |
| Azolla caroliniana | -- | -- | -- | .13 |
| Baccharis halimifolia | -- | .10 | .56 | .02 |
| Bacopa caroliniana | -- | -- | .28 | .34 |
| Bacopa monnieri | -- | .92 | 4.75 | 1 44 |
| Bacopa rotundifolia | -- | .11 | .32 | 00 |
| Batis maritima | 4.41 | -- | -- | -- |
| Bidens laevis | -- | -- | -- | .08 |
| Borrichia frutescens | .67 | .11 | -- | -- |
| Brasenia schreberi | -- | -- | -- | .67 |
| Caboma caroliniana | -- | -- | -- | .71 |
| Carex sp. | -- | -- | -- | .02 |
| Centella erecta | -- | -- | .16 | .12 |
| Cephalanthus occidentalis | -- | -- | -- | .21 |
| Ceratophyllum demersum | -- | -- | -- | 1.50 |
| Cladium jamaicense | -- | -- | -- | .84 |
| Colocasia antiquorum | -- | -- | -- | .39 |
| Cuscuta indecora | -- | .02 | -- | -- |

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Table 10. Continued

| Species | Vegetative Types | | | |
|---|---|---|---|---|
| | Saline | Brackish | Intermediate | Fresh |
| | Percent | | | |
| *Cynodon dactylon* | -- | -- | -- | .10 |
| *Cyperus compressus* | -- | -- | -- | .02 |
| *Cyperus odoratus* | -- | .84 | 2.18 | 1.56 |
| *Daubentonia texana* | -- | -- | .04 | .17 |
| *Decodon verticillatus* | -- | -- | -- | .51 |
| *Dichromena colorata* | -- | -- | -- | .03 |
| *Distichlis spicata* | 14.27 | 13.32 | .36 | .13 |
| *Dryopteris thelypteris* var. *haliana* | -- | -- | -- | .44 |
| *Echinochloa walteri* | -- | .36 | 2.72 | .77 |
| *Eichornia crassipes* | -- | -- | -- | 1.43 |
| *Eleocharis parvula* | -- | 2.46 | .49 | .54 |
| *Eleocharis* sp. | -- | .82 | 3.28 | 10.74 |
| *Eupatorium capillifolium* | -- | -- | -- | .05 |
| *Eupatorium* sp. | -- | -- | .08 | .03 |
| *Fimbristylis castanea* | .04 | .11 | .12 | -- |
| *Gerardia maritima* | .01 | .08 | -- | -- |
| *Heliotropium curassavicum* | -- | .02 | -- | -- |
| *Hibiscus lasiocarpus* | -- | -- | .10 | .05 |
| *Hydrocotyle bonariensis* | -- | -- | -- | .02 |
| *Hydrocotyle ranunculoides* | -- | -- | -- | .11 |
| *Hydrocotyle umbellata* | -- | -- | -- | 1.93 |
| *Hymenocallis occidentalis* | -- | -- | .04 | .14 |

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Table 10. Continued

| Species | Vegetative Types | | | |
|---|---|---|---|---|
| | Saline | Brackish | Intermediate | Fresh |
| | - - - - - - - Percent - - - - - - - | | | |
| *Hypericum virginicum* | -- | -- | -- | .07 |
| *Ipomoea stolonifera* | -- | -- | -- | .03 |
| *Ipomoea sagittata* | -- | .13 | .84 | .19 |
| *Iva frutescens* | .03 | .10 | -- | -- |
| *Juncus effusus* | -- | -- | -- | .11 |
| *Juncus roemerianus* | 10.10 | 3.93 | .72 | .60 |
| *Jussiaea alterniflora* | -- | -- | -- | .24 |
| *Jussiaea uruguayensis* | -- | -- | -- | .84 |
| *Kosteletzkya virginica* | -- | .02 | .18 | .07 |
| *Lemna minor* | -- | .02 | .16 | 2.31 |
| *Leptochloa fascicularis* | -- | .32 | 2.17 | .49 |
| *Leptochloa filiformis* | -- | -- | .04 | -- |
| *Limnobium spontia* | -- | -- | -- | .16 |
| *Lippia nodiflora* | -- | -- | -- | .06 |
| *Lycium carolinianum* | .07 | -- | -- | -- |
| *Lythrum lineare* | .01 | .16 | .18 | .07 |
| *Myrica cerifera* | -- | -- | -- | .16 |
| *Myriophyllum spicatum* | -- | .15 | .44 | 1.56 |
| *Myriophyllum heterophyllum* | -- | -- | -- | .19 |
| *Najas quadalupensis* | -- | -- | 1.03 | 1.07 |
| *Nelumbo lutea* | -- | -- | -- | .54 |
| *Nymphaea odorata/tuberosa* | -- | -- | -- | 1.15 |
| *Nymphoides aquaticum* | -- | -- | -- | .11 |

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Table 10. Continued

| Species | Vegetative Types | | | |
|---|---|---|---|---|
| | Saline | Brackish | Intermediate | Fresh |
| | - - - - - - - Percent- - - - - - - | | | |
| *Osmunda regalis* | -- | -- | .16 | .43 |
| *Ottelia alismoides* | -- | -- | -- | .03 |
| *Panicum hemitomon* | -- | -- | .76 | 25.62 |
| *Panicum repens* | -- | -- | .92 | .24 |
| *Panicum virgatum* | -- | .14 | 2.51 | .45 |
| *Panicum* sp. | -- | -- | -- | .10 |
| *Paspalum dissectum* | -- | -- | .40 | .42 |
| *Paspalum vaginatum* | -- | 1.38 | 4.46 | .35 |
| *Philoxerus vermicularis* | -- | -- | .08 | .01 |
| *Phragmites communis* | -- | .31 | 6.63 | 2.54 |
| *Pluchea foetida* | -- | -- | -- | .02 |
| *Pluchea camphorata* | -- | .87 | 2.26 | .36 |
| *Polygonum* sp. | -- | -- | -- | .56 |
| *Pontederia cordata* | -- | -- | -- | .07 |
| *Potamogeton nodosus* | -- | -- | .28 | .03 |
| *Potamogeton pusillus* | -- | -- | .24 | .62 |
| *Ruppia maritima* | -- | 3.83 | .64 | -- |
| *Sacciolepis striata* | -- | -- | -- | .06 |
| *Sagittaria falcata* | -- | -- | 6.47 | 15.15 |
| *Sagittaria latifolia* | -- | -- | -- | .21 |
| *Sagittaria platyphylla* | -- | -- | -- | .23 |
| *Sagittaria* sp. | -- | -- | .08 | -- |
| *Salicornia bigelovii* | .13 | -- | -- | -- |

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Table 10. Continued

| Species | Vegetative Types | | | |
| --- | --- | --- | --- | --- |
| | Saline | Brackish | Intermediate | Fresh |
| | - - - - - - - Percent- - - - - - - | | | |
| Salicornia virginica | .63 | -- | -- | -- |
| Salix nigra | -- | -- | -- | .06 |
| Saururus cernuus | -- | -- | -- | .16 |
| Scirpus americanus | -- | -- | 1.27 | .13 |
| Scirpus californicus | -- | -- | 1.83 | .42 |
| Scirpus olneyi | -- | 4.97 | 3.26 | .45 |
| Scirpus robustus | .66 | 1.78 | .68 | -- |
| Scirpus validus | -- | .08 | -- | -- |
| Sesbania exaltata | -- | .06 | .20 | -- |
| Sesuvium portulacastrum | -- | .04 | -- | -- |
| Setaria glauca | -- | .06 | -- | -- |
| Setaria magna | -- | -- | -- | .03 |
| Solidago sp. | -- | -- | .04 | .08 |
| Spartina alterniflora | 62.14 | 4.77 | .86 | -- |
| Spartina cynosuroides | -- | .89 | 1.19 | .02 |
| Spartina patens | 5.99 | 55.22 | 34.01 | 3.74 |
| Spartina spartineae | .01 | .04 | 1.48 | -- |
| Spirodela polyrhiza | -- | -- | -- | .20 |
| Suaeda linearis | .23 | -- | -- | -- |
| Taraxacum officinale | -- | -- | .02 | -- |
| Taxodium distichum | -- | -- | -- | .02 |
| Typha spp. | -- | -- | .98 | 1.57 |
| Utricularia cornuta | -- | -- | -- | 1.68 |

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Table 10. Continued

| Species | Vegetative Types | | | |
|---|---|---|---|---|
| | Saline | Brackish | Intermediate | Fresh |
| | - - - - - - - Percent- - - - - - - | | | |
| *Utricularia subulata* | -- | -- | -- | .21 |
| *Vallisneria americana* | -- | .08 | -- | -- |
| *Vigna repens* | -- | 1.20 | 3.84 | 1.43 |
| *Woodwardia virginica* | -- | -- | -- | .28 |
| *Zizaniopsis miliacea* | -- | -- | -- | 1.20 |

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dominant species making up 62 percent of the species composition. Other species comprising more than 5 percent of the marsh vegetation were Distichlis spicata, Juncus roemerianus and Spartina patens, in order of abundance. Of the remaining 13 species only Batis maritima made up more than 1 percent of the composition.

Brackish Vegetative Type. Forty species were encountered during the study within the brackish type (Table 10). The dominant species was Spartina patens, comprising 55 percent of the vegetation. Distichlis spicata made up 13.3 percent, and of the remaining 38 species five were secondary species (2 to 5 percent). These were Scirpus olneyi, Spartina alterniflora, Juncus roemerianus, Ruppia maritima and Eleocharis parvula in descending order of abundance.

Intermediate Vegetative Type. The intermediate type was composed of 54 species (Table 10). Spartina patens was also dominant in this type making up one-third of the vegetation. Two other plants occurred as major species: Phragmites communis and Sagittaria falcata. This type had a large number of species which were classified as secondary and 11 species fell within this range. Five species were listed as minor species, and none of the remaining 35 species comprised more than 1 percent of the vegetative composition.

Fresh Vegetative Type. Of the 118 species occurring on the transect lines, 93 were in the fresh marsh. The dominant species in this type was Panicum hemitomon, which made up one-fourth of the vegetation (Plate 5). Other major species included Sagittaria falcata, Eleocharis sp. and Alternanthera philoxeroides. Secondary species were Spartina patens, Phragmites communis and Lemna minor. Of the

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**Plate 5**

A dense stand of *Panicum hemitomon* with scattered *Phragmites communis*, characteristic of the fresh vegetative type

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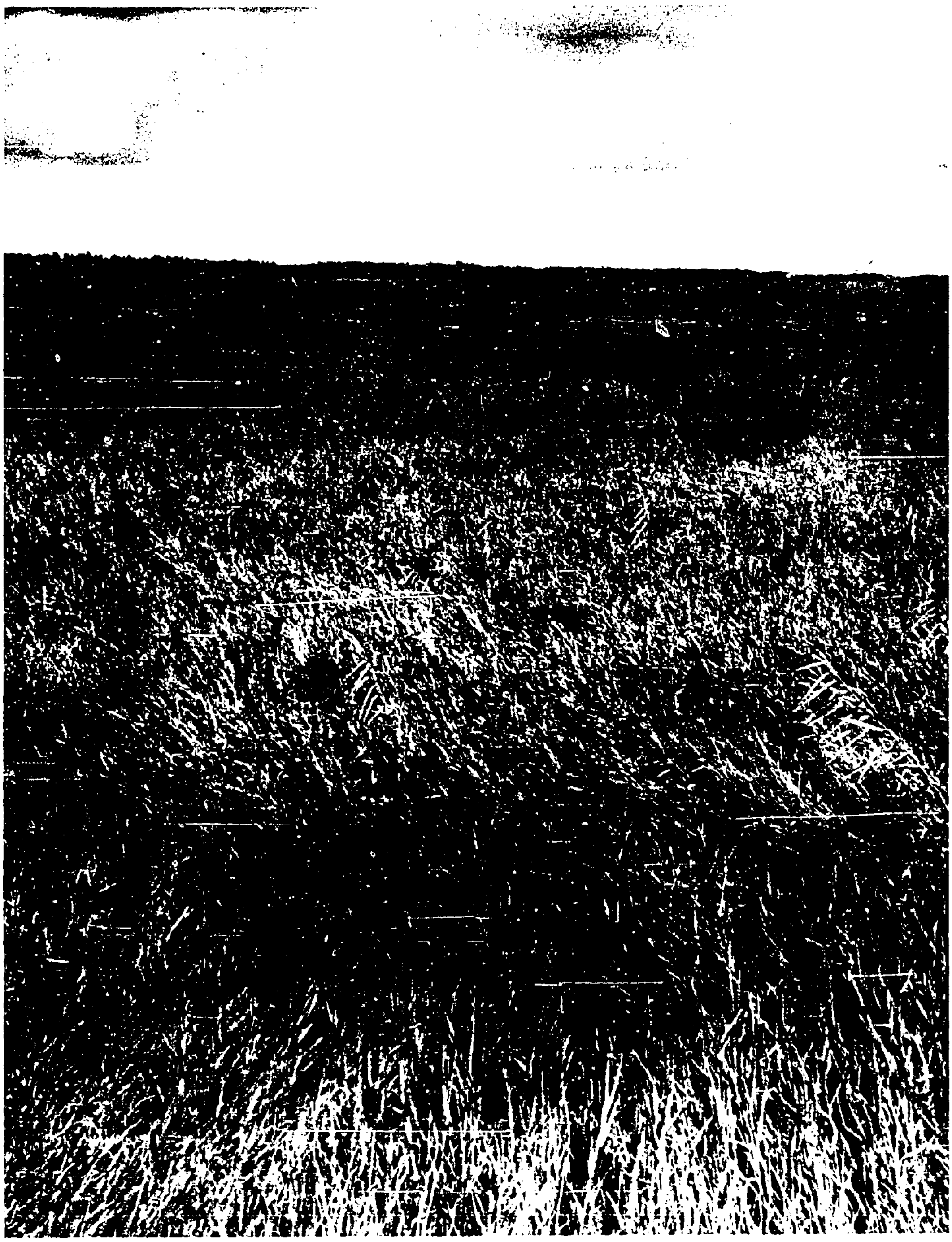

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remaining 86 species, 12 were of minor occurrence and the remainder made up less than 1 percent of the species composition (Table 10).

## Species Composition of Vegetative Types Within Marsh Zones

Edaphic factors in a particular marsh influence the plants occupying the area; therefore, marsh zones having different makeup insofar as vegetative types, would likely have a different species composition. For instance, a marsh zone with a high percentage of fresh marsh would not have the same species composition as another with a high percentage salt marsh. Consequently, a more valid comparison can be made by comparing vegetative types within marsh zones.

Saline Vegetative Type. The study included only the saline type of the Chenier Plain and Inactive Delta Zones. Although a small amount of saline marsh did occur on the Active Delta, this was not included in the study. The saline type in both the Chenier Plain and Inactive Delta (Table 11) included the smallest number of plant species with 10 and 15, respectively. The outstanding difference in the two types was the dominant species. *Distichlis spicata* was the dominant in the Chenier Plain and *Spartina alterniflora* the dominant in the Inactive Delta (Plate 6), with each species making up over one-half of the vegetation. Also, the second ranking species in each type was the dominant in the other type in similar proportions. The third ranking species in the Chenier Plain salt marsh was *Scirpus robustus* and in the Inactive Delta, *Juncus roemerianus*. The composition of the remaining species was similar.

Brackish Vegetative Type. The brackish marsh of the Inactive Delta (Table 12) contained more species (33) than that of either the

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Table 11. Plant species composition of the saline vegetative type by marsh zones, August, 1968

| Species | Marsh Zones: Chenier Plain | Marsh Zones: Inactive Delta |
|---|---|---|
| | - - - - - - -Percent- | - - - - - - |
| *Avicennia nitida* | -- | .65 |
| *Batis maritima* | 5.02 | 4.36 |
| *Borrichia frutescens* | 6.02 | .28 |
| *Distichlis spicata* | 57.67 | 11.19 |
| *Fimbristylis castanea* | -- | .04 |
| *Gerardia maritima* | -- | .01 |
| *Iva frutescens* | -- | .04 |
| *Juncus roemerianus* | 3.01 | 10.60 |
| *Lycium carolinianum* | 1.00 | -- |
| *Lythrum lineare* | -- | .01 |
| *Salicornia bigelovii* | 1.00 | .07 |
| *Salicornia virginica* | -- | .68 |
| *Scirpus robustus* | 9.03 | .06 |
| *Spartina alterniflora* | 13.04 | 65.62 |
| *Spartina patens* | 4.01 | 6.14 |
| *Spartina spartineae* | .20 | -- |
| *Suaeda linearis* | -- | .25 |

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**Plate 6**

A portion of the Inactive Delta Marsh Zone, where subsidence and tall growth of _Spartina_ _Alterniflora_ emphasize pond and bayou banks

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Table 12. Plant species composition of the brackish vegetative type by marsh zones, August, 1968

| Species | Marsh Zones Chenier Plain | Inactive Delta | Active Delta |
|---|---|---|---|
| | - - - - - - - Percent- | - - - - - - | |
| Acnida alabamensis | -- | .14 | -- |
| Aster sp. | -- | .11 | -- |
| Baccharis halimifolia | -- | .14 | -- |
| Bacopa monnieri | 2.31 | .39 | -- |
| Bacopa rotundifolia | .41 | -- | -- |
| Borrichia frutescens | .14 | .11 | -- |
| Cuscuta indecora | -- | .03 | -- |
| Cyperus odoratus | .68 | .93 | -- |
| Distichlis spicata | 14.26 | 13.09 | 8.54 |
| Echinochloa walteri | .75 | .21 | -- |
| Eleocharis parvula | 1.97 | 2.64 | 2.85 |
| Eleocharis sp. | .07 | 1.14 | -- |
| Fimbristylis castanea | .14 | .11 | -- |
| Gerardia maritima | .27 | -- | -- |
| Heliotropium curassavicum | -- | .03 | -- |
| Ipomoea sagittata | .07 | .16 | -- |
| Iva frutescens | -- | .15 | -- |
| Juncus roemerianus | 1.02 | 5.21 | -- |
| Kosteletzkya virginica | -- | .03 | -- |
| Lemna minor | .07 | -- | -- |
| Leptochloa fascicularis | .27 | .35 | -- |
| Lythrum lineare | .04 | .21 | -- |

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Table 12. Continued

| Species | Marsh Zones | | |
| --- | --- | --- | --- |
| | Chenier Plain | Inactive Delta | Active Delta |
| | - - - - - - - | Percent- | - - - - - - |
| *Myriophyllum spicatum* | -- | .22 | -- |
| *Panicum virgatum* | .20 | .11 | -- |
| *Paspalam vaginatum* | 4.19 | .30 | -- |
| *Phragmites communis* | .34 | -- | 10.82 |
| *Pluchea camphorata* | .34 | 1.11 | -- |
| *Ruppia maritima* | 7.35 | 2.53 | -- |
| *Scirpus olneyi* | 6.29 | 4.55 | .95 |
| *Scirpus robustus* | 2.64 | 1.27 | 7.59 |
| *Scirpus validus* | -- | -- | 3.79 |
| *Sesbania exaltata* | .10 | .05 | -- |
| *Sesuvium portulacastrum* | .14 | -- | -- |
| *Setaria glauca* | .07 | .05 | -- |
| *Spartina alterniflora* | .61 | 4.89 | 58.44 |
| *Spartina cynosuroides* | .61 | 1.01 | .38 |
| *Spartina patens* | 54.44 | 56.93 | 6.64 |
| *Spartina spartineae* | .14 | -- | -- |
| *Vallisneria americana* | -- | .11 | -- |
| *Vigna repens* | .07 | 1.69 | -- |

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Chenier Plain or the Active Delta. Spartina patens made up 54.4 percent of the vegetation of the Chenier Plain and 56.9 percent of the Inactive Delta. However, in the brackish type of the Active Delta this species comprised only 6.6 percent, and Spartina alterniflora was dominant with 58.4 percent. Similarly, Distichlis spicata was the second ranking brackish species in the Chenier Plain and Inactive Delta with 14.3 and 14.1 percent, respectively. In the Active Delta this species ranked third behind Phragmites communis.

Intermediate Vegetative Type. The Chenier Plain intermediate type (Table 13) produced more species than did this type in the other marsh zones. Also, the number of species within vegetative types of the Chenier Plain doubled from the brackish type to the intermediate type. The species composition of the intermediate type within the Chenier Plain and Inactive Delta were very similar, and again Spartina patens was dominant with 40.5 and 34.4 percent, respectively. However, in the Active Delta Phragmites communis was the dominant with Spartina patens making up only 1.5 percent of the vegetation of the intermediate marsh.

Fresh Vegetative Type. The fresh marsh had more species than the other vegetative types in both the Chenier Plain and Inactive Delta (Table 14). However, in fresh marsh of the Active Delta only 10 species occurred at the sampling points. Considerable variation was noted in the species composition of fresh marsh between marsh zones. The dominant in the Chenier Plain was Sagittaria falcata, while in the Inactive Delta Panicum hemitomon was dominant and in the Active Delta Phragmites communis was the main species. The dominant

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Table 13. Plant species composition of the intermediate vegetative type by marsh zones, August, 1968

| Species | Marsh Zones Chenier Plain | Inactive Delta | Active Delta |
|---|---|---|---|
| | - - - - - - - Percent- | - - - - - - - | |
| *Acnida alabamensis* | .54 | .04 | -- |
| *Alternanthera philoxeroides* | 4.25 | -- | 2.60 |
| *Aster* sp. | -- | 1.16 | -- |
| *Baccharis halimifolia* | .31 | 1.06 | -- |
| *Bacopa caroliniana* | .54 | -- | -- |
| *Bacopa monnieri* | 3.97 | 4.21 | 10.41 |
| *Bacopa rotundifolia* | .62 | -- | -- |
| *Centella erecta* | -- | .42 | -- |
| *Cyperus odoratus* | 2.97 | 1.59 | .45 |
| *Daubentonia texana* | .08 | -- | -- |
| *Distichlis spicata* | .39 | .42 | -- |
| *Echinochloa walteri* | 4.17 | 1.08 | 1.49 |
| *Eleocharis parvula* | .03 | 1.16 | .37 |
| *Eleocharis* sp. | .34 | 7.35 | 3.12 |
| *Eupatorium* sp. | .08 | .11 | -- |
| *Fimbristylis castanea* | .23 | -- | -- |
| *Hibiscus lasiocarpus* | .03 | .21 | -- |
| *Hymenocallis occidentalis* | .08 | -- | -- |
| *Ipomoea sagittata* | 1.34 | .40 | -- |
| *Juncus roemerianus* | .77 | .85 | -- |
| *Kosteletzkya virginica* | -- | .49 | -- |
| *Lemna minor* | .23 | .11 | -- |

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Table 13. Continued

| Species | Marsh Zones: Chenier Plain | Inactive Delta | Active Delta |
|---|---|---|---|
| | - - - - - - - Percent- | - - - - - - - | |
| Leptochloa fascicularis | 2.42 | 2.43 | -- |
| Leptochloa filiformis | .08 | -- | -- |
| Lythrum lineare | .05 | .42 | -- |
| Myriophyllum spicatum | -- | -- | 4.09 |
| Najas quadalupensis | .54 | 2.01 | -- |
| Osmunda regalis | -- | .42 | -- |
| Panicum hemitomon | -- | 1.16 | 2.97 |
| Panicum repens | -- | -- | 8.55 |
| Panicum virgatum | 1.93 | 4.02 | -- |
| Paspalum dissectum | .77 | -- | -- |
| Paspalam vaginatum | 7.10 | 2.12 | -- |
| Philoxerus vermicularis | -- | -- | .74 |
| Phragmites communis | 3.40 | .53 | 43.64 |
| Pluchea camphorata | 1.51 | 3.30 | 2.16 |
| Potamogeton nodosus | .54 | -- | -- |
| Potamogeton pusillus | .15 | -- | 1.49 |
| Ruppia maritima | .31 | .85 | 1.49 |
| Sagittaria falcata | 6.15 | 7.58 | 4.09 |
| Sagittaria sp. | -- | .21 | -- |
| Scirpus americanus | 1.70 | -- | 3.72 |
| Scirpus californicus | 3.48 | .11 | -- |
| Scirpus olneyi | 2.93 | 4.64 | -- |

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Table 13. Continued

| Species | Marsh Zones | | |
|---|---|---|---|
| | Chenier Plain | Inactive Delta | Active Delta |
| | - - - - - - - Percent- - - - - - - - | | |
| *Scirpus robustus* | .85 | .64 | -- |
| *Sesbania exaltata* | .39 | -- | -- |
| *Solidago* sp. | -- | -- | .37 |
| *Spartina alterniflora* | .39 | -- | 6.17 |
| *Spartina cynosuroides* | .23 | 2.86 | -- |
| *Spartina patens* | 40.49 | 34.41 | 1.49 |
| *Spartina spartineae* | 2.85 | -- | -- |
| *Taraxacum officinale* | -- | .06 | -- |
| *Typha* spp. | -- | 2.43 | .59 |
| *Vigna repens* | .77 | 9.14 | -- |

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Table 14. Plant species composition of the fresh vegetative type by marsh zones, August, 1968

| Species | Marsh Zones: Chenier Plain | Marsh Zones: Inactive Delta | Marsh Zones: Active Delta |
|---|---|---|---|
| | - - - - - - - - Percent- - - - - - - - | | |
| *Acnida alabamensis* | -- | .03 | -- |
| *Aeschynomene virginica* | -- | .11 | -- |
| *Alternanthera philoxeroides* | 10.24 | 2.44 | 8.69 |
| *Aster* sp. | -- | .21 | -- |
| *Azolla caroliniana* | -- | .21 | -- |
| *Baccharis halimifolia* | .05 | -- | -- |
| *Bacopa caroliniana* | .89 | .09 | -- |
| *Bacopa monnieri* | .63 | 2.01 | -- |
| *Bidens laevis* | -- | .13 | -- |
| *Brasenia schreberi* | 2.06 | -- | -- |
| *Caboma caroliniana* | 2.21 | -- | -- |
| *Carex* sp. | -- | .03 | -- |
| *Centella erecta* | .10 | .14 | -- |
| *Cephalanthus occidentalis* | .55 | .05 | -- |
| *Ceratophyllum demersum* | 1.31 | 1.76 | -- |
| *Cladium jamaicense* | .05 | 1.34 | -- |
| *Colocasia antiquorum* | -- | .63 | -- |
| *Cynodon dactylon* | .30 | -- | -- |
| *Cyperus compressus* | -- | .03 | -- |
| *Cyperus odoratus* | .65 | 2.18 | -- |
| *Daubentonia texana* | .53 | -- | -- |
| *Decodon verticillatus* | -- | .83 | -- |

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Table 14. Continued

| Species | Marsh Zones: Chenier Plain | Marsh Zones: Inactive Delta | Marsh Zones: Active Delta |
|---|---|---|---|
| | Percent | Percent | Percent |
| *Dichromena colorata* | -- | .05 | -- |
| *Distichlis spicata* | .20 | .11 | -- |
| *Dryopteris thelypteris* var. *haliana* | -- | .72 | -- |
| *Echinochloa walteri* | .67 | .89 | -- |
| *Eichornia crassipes* | .10 | 1.72 | 5.53 |
| *Eleocharis parvula* | .40 | .66 | -- |
| *Eleocharis* sp. | 5.38 | 14.61 | -- |
| *Eupatorium capillifolium* | -- | .08 | -- |
| *Eupatorium* sp. | -- | .05 | -- |
| *Hibiscus lasiocarpus* | .05 | .05 | -- |
| *Hydrocotyle bonariensis* | -- | .03 | -- |
| *Hydrocotyle ranunculoides* | -- | .17 | -- |
| *Hydrocotyle umbellata* | .57 | 2.84 | -- |
| *Hymenocallis occidentalis* | .37 | .03 | -- |
| *Hypericum virginicum* | -- | .11 | -- |
| *Ipomoea stolonifera* | -- | .05 | -- |
| *Ipomoea sagittata* | -- | .32 | -- |
| *Juncus effusus* | .20 | .08 | -- |
| *Juncus roemerianus* | 1.76 | .05 | -- |
| *Jussiaea alterniflora* | .10 | .34 | -- |
| *Jussiaea uruguayensis* | 1.41 | .62 | -- |
| *Kosteletzkya virginica* | -- | .11 | -- |

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Table 14. Continued

| Species | Marsh Zones | | |
|---|---|---|---|
| | Chenier Plain | Inactive Delta | Active Delta |
| | - - - - - - - Percent- - - - - - - | | |
| *Lemna minor* | .05 | 2.94 | 7.85 |
| *Leptochloa fascicularis* | .40 | .58 | -- |
| *Limnobium spongia* | .02 | .25 | -- |
| *Lippia nodiflora* | -- | .09 | -- |
| *Lythrum lineare* | -- | .10 | -- |
| *Myrica cerifera* | -- | .26 | -- |
| *Myriophyllum spicatum* | -- | -- | 25.29 |
| *Myriophyllum heterophyllum* | .60 | -- | -- |
| *Najas quadalupensis* | 3.32 | -- | -- |
| *Nelumbo lutea* | 1.46 | .11 | -- |
| *Nymphaea odorata/tuberosa* | 3.57 | -- | -- |
| *Nymphoides aquaticum* | .35 | -- | -- |
| *Osmunda regalis* | -- | .71 | -- |
| *Ottelia alismoides* | .10 | -- | -- |
| *Panicum hemitomon* | 14.51 | 34.00 | -- |
| *Panicum repens* | -- | -- | 3.95 |
| *Panicum virgatum* | .30 | .58 | -- |
| *Panicum* sp. | -- | .16 | -- |
| *Paspalum dissectum* | 1.31 | -- | -- |
| *Paspalam vaginatum* | .69 | .21 | -- |
| *Philoxerus vermicularis* | .05 | -- | -- |
| *Phragmites communis* | -- | .40 | 37.30 |

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Table 14. Continued

| Species | Marsh Zones | | |
|---|---|---|---|
| | Chenier Plain | Inactive Delta | Active Delta |
| | - - - - - - -Percent - - - - - - - | | |
| *Pluchea foetida* | -- | .03 | -- |
| *Pluchea camphorata* | .05 | .56 | -- |
| *Polygonum* sp. | .10 | .85 | -- |
| *Pontederia cordata* | .08 | .08 | -- |
| *Potamogeton nodosus* | .10 | -- | -- |
| *Potamogeton pusillus* | .86 | .26 | 2.90 |
| *Sacciolepis striata* | .20 | -- | -- |
| *Sagittaria falcata* | 24.69 | 11.68 | -- |
| *Sagittaria latifolia* | -- | .34 | -- |
| *Sagittaria platyphylla* | -- | -- | 3.69 |
| *Salix nigra* | .20 | -- | -- |
| *Saururus cernuus* | -- | .05 | 2.11 |
| *Scirpus americanus* | .40 | -- | -- |
| *Scirpus californicus* | .81 | .26 | -- |
| *Scirpus olneyi* | -- | .72 | -- |
| *Setaria magna* | -- | .05 | -- |
| *Solidago* sp. | -- | .12 | -- |
| *Spartina cynosuroides* | -- | .03 | -- |
| *Spartina patens* | 9.56 | 1.08 | -- |
| *Spirodela polyrhiza* | -- | .05 | 2.69 |
| *Taxodium distichum* | -- | .03 | -- |
| *Typha* spp. | .20 | 2.44 | -- |

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Table 14. Continued

| Species | Marsh Zones Chenier Plain | Inactive Delta | Active Delta |
|---|---|---|---|
| | - - - - - - - Percent- - - - - - - - | | |
| *Utricularia cornuta* | 4.48 | .39 | -- |
| *Utricularia subulata* | .66 | -- | -- |
| *Vigna repens* | .05 | 2.31 | -- |
| *Woodwardia virginica* | -- | .45 | -- |
| *Zizaniopsis miliacea* | .05 | 1.92 | -- |

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species in the Chenier Plain and Inactive Delta were the second ranking species in the other zone. In the Active Delta *Myriophyllum spicatum*, an aquatic species, ranked second.

## Plant Coverage

Few studies in the Louisiana Coastal Marshes have considered plant coverage. Plant coverage provides information on the degree to which a marsh is vegetated as compared to non-vegetated or open. The open portion of the marsh represents potential sites for plant growth.

The study showed only slight variation in plant coverage between vegetative types (Table 15). Nevertheless, a pattern was evident and, with the exception of the saline type of the Chenier Plain, greatest plant coverage was in the fresh type. Lowest coverage in all marsh zones was found in the brackish type.

Harris and Chabreck (1958) evaluated hurricane damage to Inactive Delta Marsh on Marsh Island. The line-intercept method was used to determine the extent of marsh openings before and after a hurricane. Working in brackish type they determined that the marsh was 86.4 percent vegetated before the hurricane and 67.1 percent vegetated following the hurricane.

Studies by Chabreck (1960) on Rockefeller Refuge in the Chenier Plain Marsh Zone determined the vegetative coverage of various types. That study reported little difference among vegetative types, and listed the brackish type as 62.0 percent vegetated, intermediate as 61.5 percent vegetated and fresh as 69.6 percent vegetated.

Studies by Harris and Webert (1962) sampled marshes with high nutria populations and listed the brackish type on Marsh Island as

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Table 15. Plant coverage of vegetative types within marsh zones, August, 1968

| Marsh Zones | Vegetative Types Saline | Brackish | Intermediate | Fresh |
|---|---|---|---|---|
| Chenier Plain | 79.8 | 67.6 | 73.7 | 77.0 |
| Inactive Delta | 73.1 | 71.9 | 77.5 | 81.9 |
| Active Delta | -- | 55.5 | 76.6 | 87.2 |
| Mean | 73.5 | 70.2 | 75.3 | 80.6 |

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63.0 percent vegetated. Two separate intermediate marshes on the Chenier Plain were sampled during that study, and Harris and Webert (1962) reported considerable variation in plant coverage (8.0 percent and 69.7 percent). The plant coverage for two fresh marshes was listed as 10.6 percent and 2.0 percent.

Fogarty (1965) used the line-intercept method to sample marsh east of Calcasieu Lake in the Chenier Plain Zone, and reported the following plant coverages for vegetative types: brackish type (86.3 percent), intermediate type (68.1 percent), and fresh type (55.0 percent).

## Water Salinity

The term water salinity as used in this study refers to the total salts in water which is readily available in small depressions in the marsh. Penfound and Hathaway (1938) referred to such water as free soil water, and stated that the vegetative types in the Inactive Delta Zone were closely correlated with salinity. Free soil water in a marsh was generally more saline than surface water on the marsh or water in adjacent bayous and lakes.

In describing the salinity ranges of the vegetative types, Penfound and Hathaway (1938) reported that in the fresh type they were unable to detect any salt. The salinity range of the nearly fresh type (intermediate) was from 0 to 5 ppt, the brackish was from 5 to 20 ppt and the saline type extended from 20 ppt upward to 50 ppt.

Chamberlain (1957) studied the relation of marsh plants to salinity on the Chenier Plain and subdivided the marsh into three

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vegetative types. The fresh type included the fresh and intermediate marsh plants with a salinity range from 1.5 ppt to 6.0 ppt. The brackish type was from 6.0 ppt to 17.0 ppt and the saline type generally ranged above 17.0 ppt. Considerable overlap was noted in certain instances. Chamberlain (1957) stated that the salinity ranges were broad for all of the types and that only the brackish marsh agreed with the figures presented by Penfound and Hathaway (1938). Chamberlain further stated that the application of the salinity ranges, as reported by Penfound and Hathaway (1938) to vegetative types outside the Inactive Delta was probably not justifiable.

Water salinities during the present study (Table 16) in the Inactive Delta varied considerably from those presented by Penfound and Hathaway (1938). They were unable to detect salt in the fresh marsh, using hydrometers, but during this study the type averaged 1.14 ppt in the Inactive Delta Zone. The intermediate and brackish marsh salinities were similar in both studies; however, in the saline type, the Penfound and Hathaway (1938) readings were much greater than those reported by this study, possibly reflecting differences in analytical methods and time.

A comparison of the water salinities reported by Chamberlain (1957) with those in Table 16 for the Chenier Plain, show that salinities during this study were slightly below those reported by Chamberlain.

A comparison among the zones listed in Table 16 indicate that the water salinities of the Chenier Plain are slightly below those of

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Table 16. Water salinity of vegetative types within marsh zones, August, 1968

| Marsh Zones | Vegetative Types | | | |
|---|---|---|---|---|
| | Saline | Brackish | Intermediate | Fresh |
| | - - - - - - -Parts per thousand- - - - - - - | | | |
| Chenier Plain: | | | | |
| Range | 9.3-20.8 | 1.0-9.6 | 0.5-6.0 | 0.1-2.0 |
| Mean | 14.59 | 4.13 | 2.57 | 0.74 |
| C.I.[a] | ±8.79 | ± .90 | ± .88 | ± .23 |
| No. Samples | 4 | 33 | 18 | 32 |
| Inactive Delta: | | | | |
| Range | 8.1-29.4 | 4.3-18.4 | 2.4-8.3 | 0.1-3.4 |
| Mean | 18.25 | 9.93 | 4.45 | 0.14 |
| C.I. | ±1.81 | ± .94 | ±1.41 | ± .32 |
| No. Samples | 59 | 72 | 15 | 51 |
| Active Delta: | | | | |
| Range | | 1.3-13.1 | 0.7-5.9 | 0.4-2.6 |
| Mean | | 8.74 | 2.38 | 0.95 |
| C.I. | | ±6.60 | ±7.64 | ± .20 |
| No. Samples | | 5 | 3 | 10 |
| Entire Coast: | | | | |
| Range | 8.1-29.4 | 1.0-18.4 | 0.5-8.3 | 0.1-3.4 |
| Mean | 18.08 | 8.17 | 3.34 | 0.98 |
| C.I. | ±1.73 | ± .86 | ± .80 | ± .20 |
| No. Samples | 63 | 110 | 36 | 93 |

[a]Confidence interval at the 95% level.

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the Inactive Delta. Readings from the fresh and intermediate type of the Active Delta correspond with those of the Chenier Plain, but the salinities of the brackish marshes of the Active Delta are more similar to those of the Inactive Delta.

The isohaline map of the Louisiana coast (Figure 2) shows that high water salinities extend inland for greater distances in the Inactive Delta. Salinities in the Active Delta are mostly at very low levels.

## Soil Salinity

Soil salinities vary from surface water salinities in a marsh, but a definite relationship exists between the two (Joanen, 1964). Soil salinity was expressed on a wet weight basis, and the salinity of free soil water (Table 16) in vegetative types sampled during this study was very similar to the soil salinity (Table 17), with the exception of the saline vegetative type. The water salinity of the Chenier Plain salt marsh was almost double that of the soil salinity, and in the Inactive Delta salt marsh, water salinities were 70 percent greater than soil salinities.

Soil salinities, as shown in Table 17, increased rapidly in all marsh zones from the fresh to intermediate type. Similar increases were noted from the intermediate to the brackish type. However, from the brackish to the saline type, soil salinity increases were greatly reduced.

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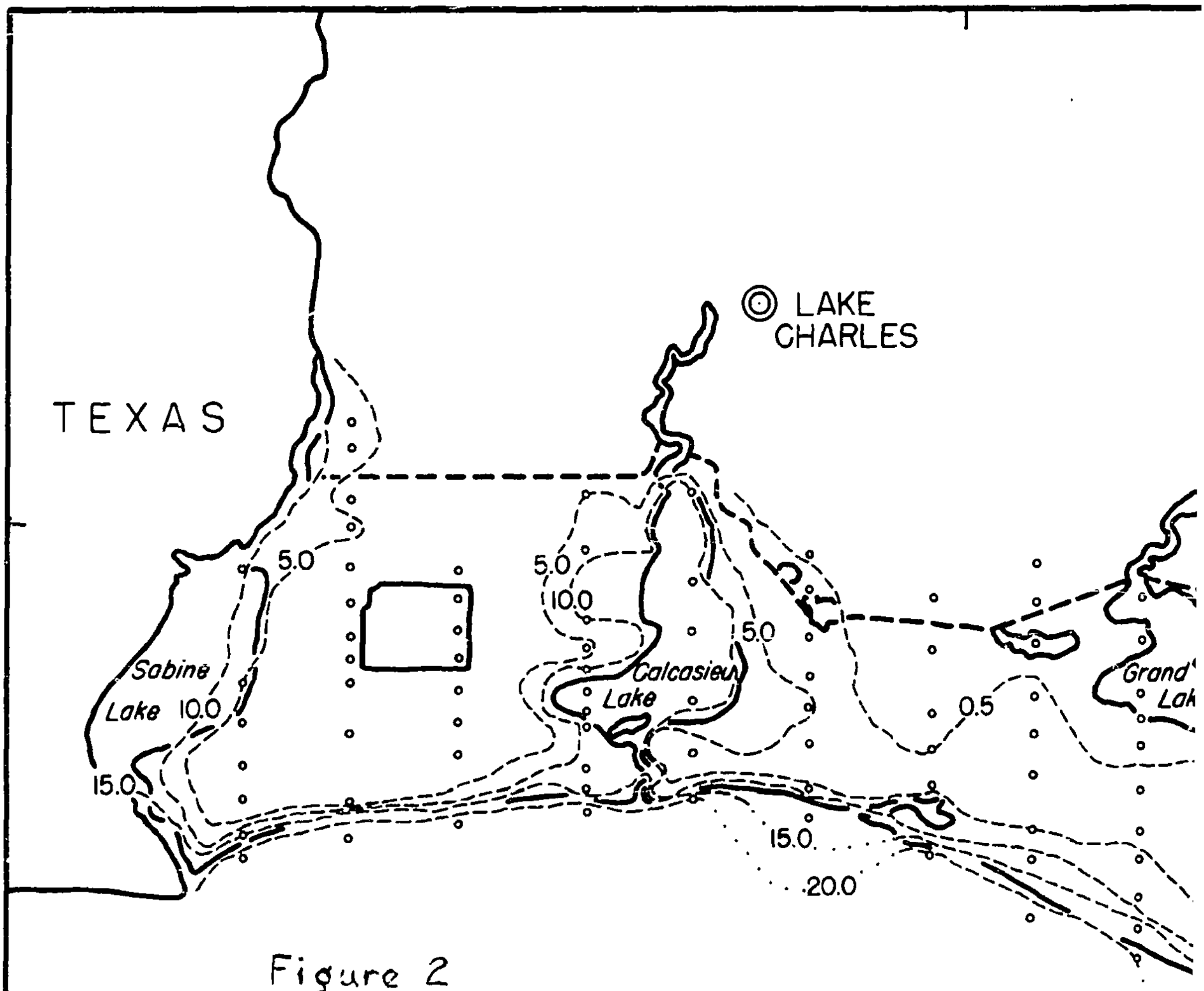


Figure 2

# ISOHALINE* MAP OF THE LOUISIANA COAST

0 5 10 15 20
Scale in miles

Prepared by: R.H. CHABRECK & A.W. PALMISANO

August, 1968

∘ Sampling station

*Water salinity in parts per thousand

93°

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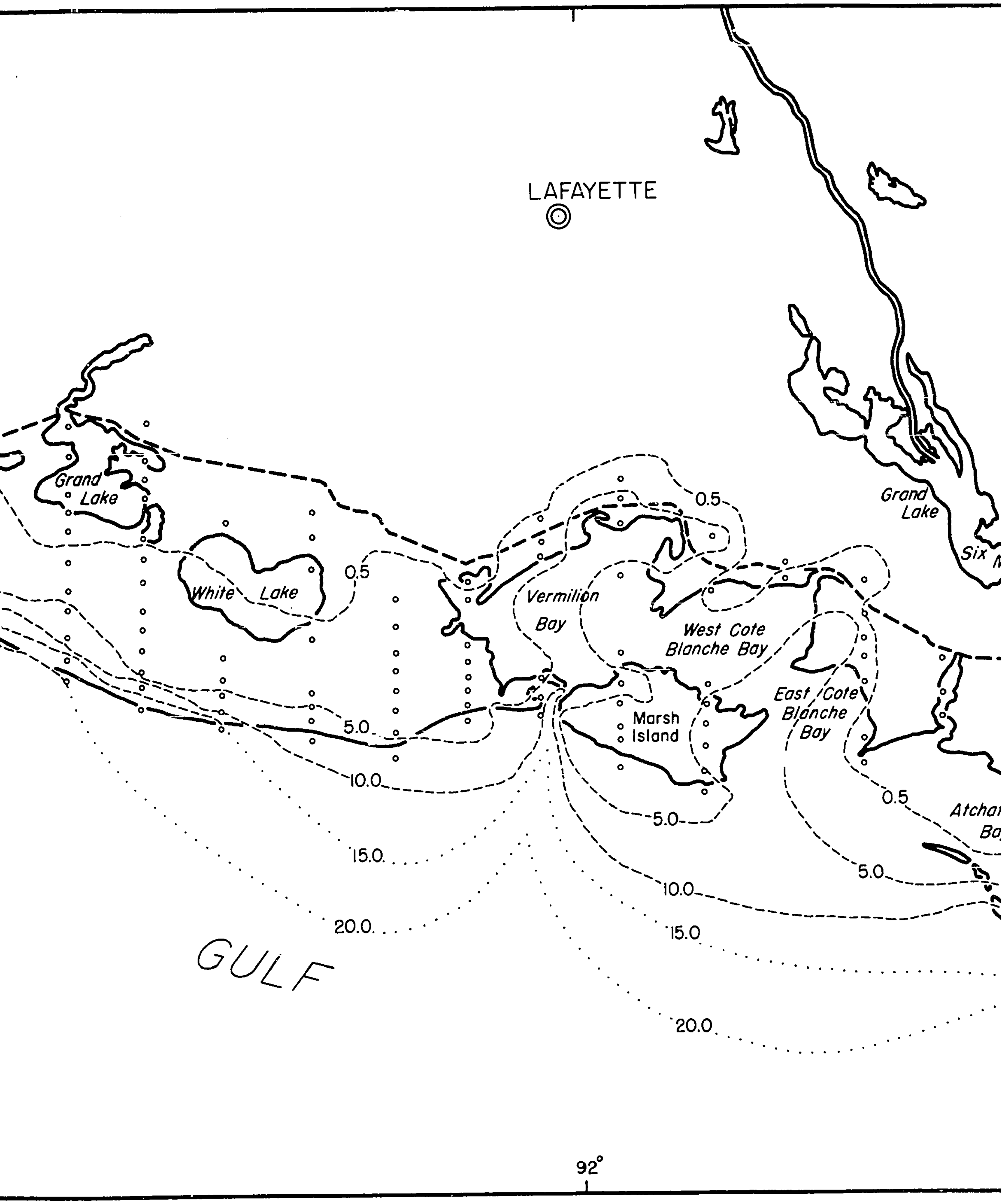


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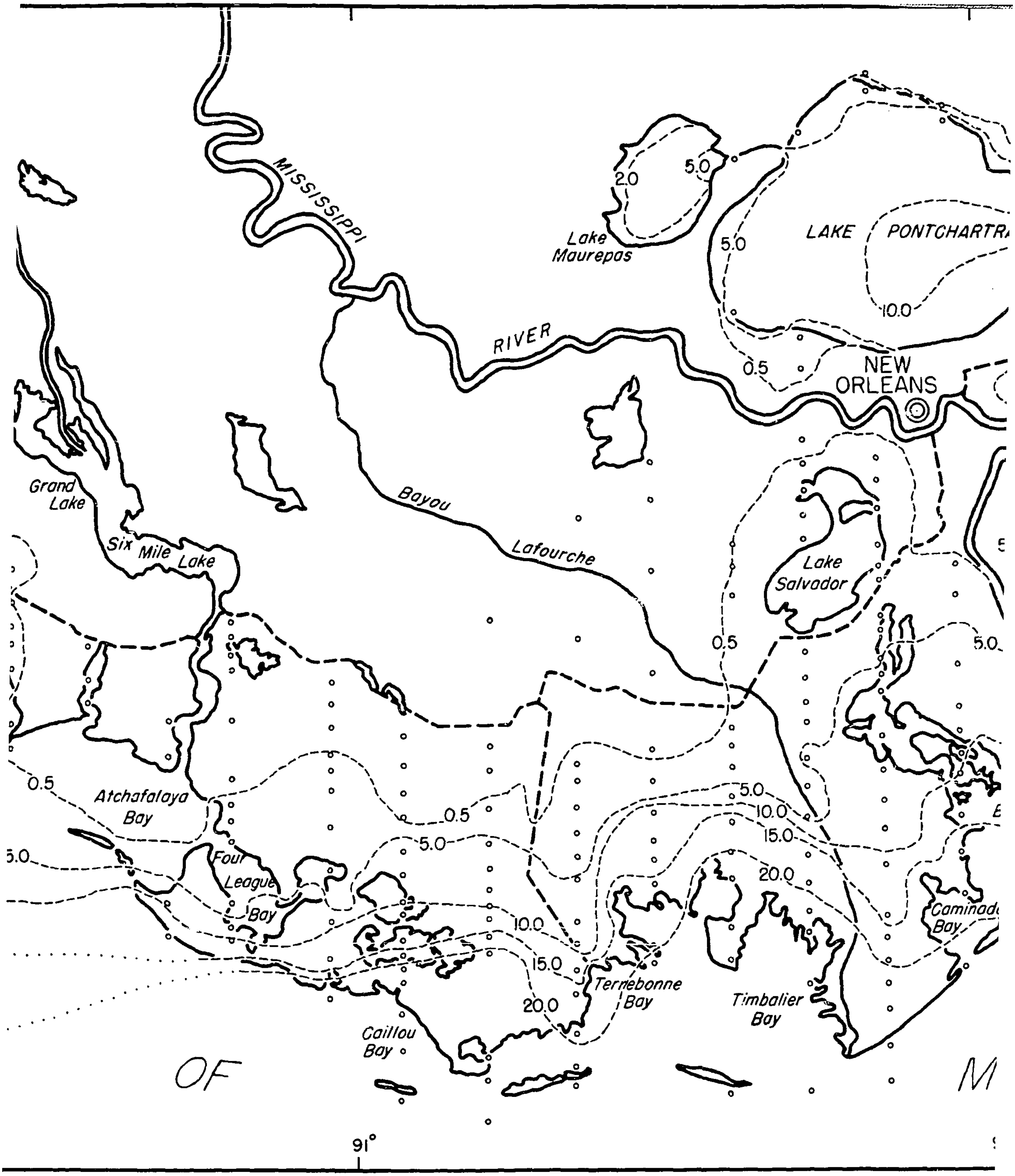


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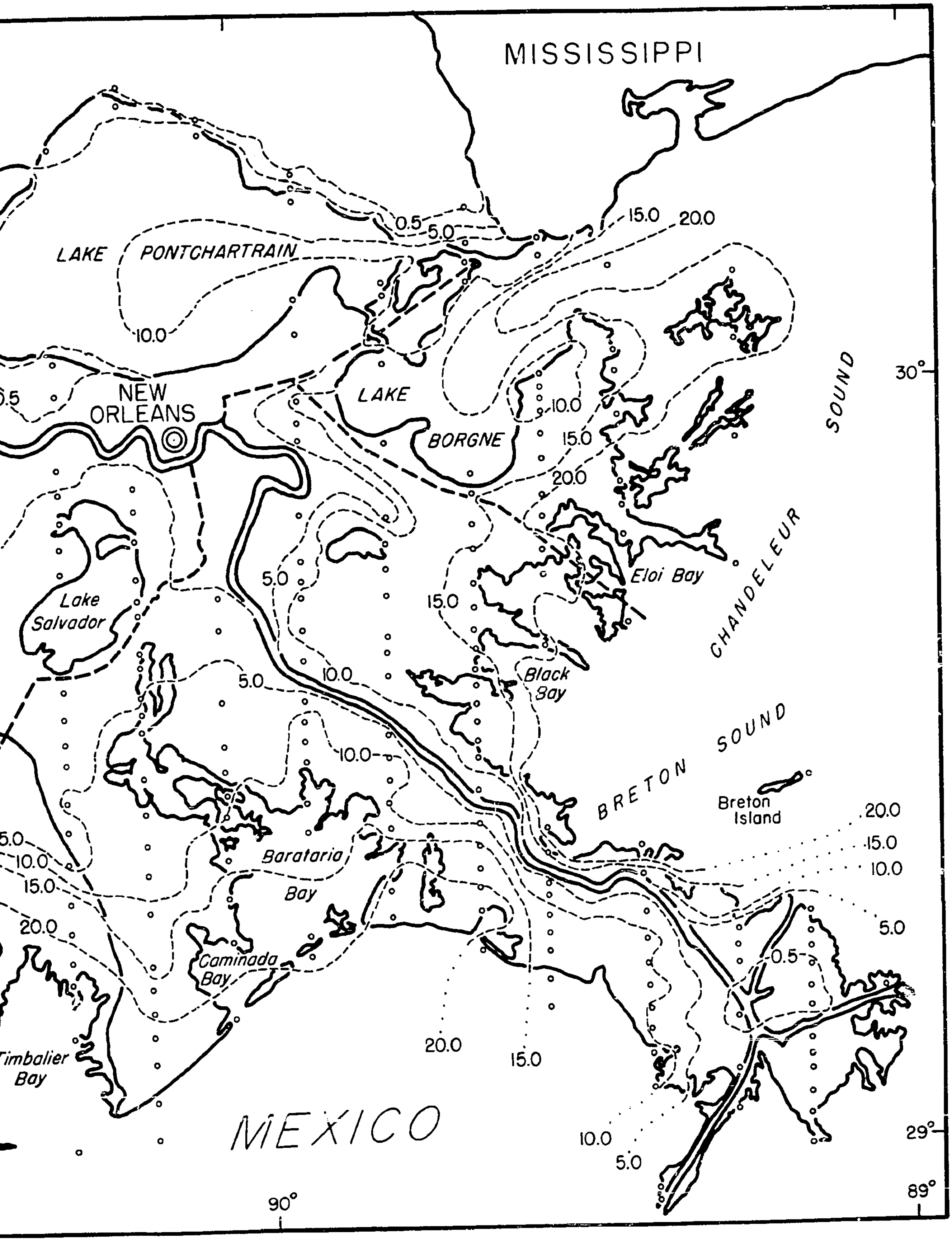


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Table 17. Soil salinity of vegetative types within marsh zones, August, 1968

| Marsh Zones | Vegetative Types: Saline | Brackish | Intermediate | Fresh |
|---|---|---|---|---|
| | - - - - - - - - Parts per thousand - - - - - - - - | | | |
| **Chenier Plain:** | | | | |
| Range | 5.7-15.5 | 2.0-12.6 | 1.5-5.2 | 0.2-2.5 |
| Mean | 7.98 | 6.40 | 2.85 | 1.23 |
| C.I.[a] | ±5.55 | ±1.09 | ± .97 | ± .34 |
| No. Samples | 5 | 35 | 18 | 25 |
| **Inactive Delta:** | | | | |
| Range | 5.1-18.9 | 3.0-15.2 | 2.0-5.3 | 0.1-3.3 |
| Mean | 10.84 | 8.16 | 3.49 | 1.30 |
| C.I. | ±1.01 | ± .72 | ±1.01 | ± .28 |
| No. Samples | 54 | 80 | 13 | 56 |
| **Active Delta:** | | | | |
| Range | -- | 3.6-13.4 | 2.2-4.6 | 0.4-2.2 |
| Mean | -- | 8.07 | 3.07 | 1.03 |
| C.I. | -- | ±6.60 | ±3.27 | ± .69 |
| No. Samples | -- | 4 | 3 | 6 |
| **Entire Coast:** | | | | |
| Range | 5.1-18.9 | 2.0-15.2 | 1.5-5.3 | 0.1-3.3 |
| Mean | 10.60 | 7.64 | 3.11 | 1.26 |
| C.I. | ± .10 | ± .59 | ± .62 | ± .20 |
| No. Samples | 59 | 119 | 34 | 87 |

[a]Confidence interval at the 95% level.

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## Organic Matter

Tests for soil organic matter (Table 18) showed a steady increase from the saline to the fresh marsh on both the Chenier Plain and Inactive Delta Marsh Zones. However, results from the Active Delta were just the opposite, and the percent organic matter decreased from the brackish to the fresh type. Sediment is carried through the Gulf of Mexico and deposited in the salt marshes on the Chenier Plain and Inactive Delta Zones, hence the high amount of mineral soil in those areas. On the Active Delta sediment is carried by the Mississippi River and deposited in the fresh marshes, resulting in a high mineral soil in that type. Lytle and Driskell (1954) examined marsh soils in St. Mary Parish on the Inactive Delta and reported a direct relationship between water soluable salts and the organic matter content of marsh soil. Penfound and Hathaway (1938) reported relatively low organic matter content in fresh and saline marshes, but very high content in brackish marshes.

Mean values for soil organic matter content were much higher for vegetative types within the Inactive Delta Zone, than were values for corresponding types within the Chenier Plain Zone. Marsh elevations are slightly higher in the Chenier Plain; consequently, increased oxidation of the soil was probably the main factor in reducing the organic matter content. The map of percent organic matter for the Louisiana Coast (Figure 3) shows the variation among marsh zones, and the high organic content of soils in the Inactive Delta Zone.

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Table 18. Soil organic matter of vegetative types within marsh zones, August, 1968

| Marsh Zones | Vegetative Types | | | |
|---|---|---|---|---|
| | Saline | Brackish | Intermediate | Fresh |
| | -Percent- | | | |
| Chenier Plain: | | | | |
| Range | 6.1-10.0 | 6.9-42.9 | 6.8-61.6 | 7.9-80.2 |
| Mean | 6.50 | 18.57 | 22.95 | 34.26 |
| C.I.[a] | ±3.62 | ±3.67 | ±9.73 | ±10.70 |
| No. Samples | 5 | 35 | 18 | 25 |
| Inactive Delta: | | | | |
| Range | 5.8-62.4 | 8.4-77.3 | 16.2-79.1 | 18.6-88.7 |
| Mean | 18.46 | 37.97 | 51.72 | 64.77 |
| C.I. | ±3.84 | ±4.43 | ±14.92 | ±6.56 |
| No. Samples | 55 | 80 | 13 | 56 |
| Active Delta: | | | | |
| Range | -- | 7.8-72.8 | 3.5-58.4 | 2.9-12.4 |
| Mean | -- | 24.63 | 22.60 | 6.96 |
| C.I. | -- | ±51.05 | ±77.17 | ±3.58 |
| No. Samples | -- | 4 | 3 | 6 |
| Entire Coast: | | | | |
| Range | 5.8-62.4 | 6.9-77.3 | 3.5-79.1 | 2.9-88.7 |
| Mean | 17.46 | 31.18 | 33.92 | 52.01 |
| C.I. | ±3.79 | ±3.65 | ±9.10 | ±6.43 |
| No. Samples | 60 | 119 | 34 | 87 |

[a]Confidence interval at the 95% level.

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## Comparison of Sampling Methods

### Estimated and Measured Line-Intercept Values

An attempt was made to land at the eighth station in every 2-mile interval. The landing provided a ground measurement of the vegetation at the sampling point, as a test of the accuracy of the aerial estimate of the same point. The vegetation coverage of the sampling point was used to relate the estimated values to the measured values. Observations were grouped by vegetative types, and the comparison of the estimated plant coverage and measured plant coverage are shown in Table 19.

The estimated values were slightly larger than the measured values in all cases. The differences in the values obtained were tested using t-tests of paired observations as described in Li (1964). This test revealed that the differences between the estimated and measured values were significant in all vegetative types, except the intermediate.

Even though there was a slight tendency to over-estimate the plant coverage, values obtained by the estimates were in all cases within 7 percent of the measured values (Table 19). Consequently, estimated values were considered adequate for the purpose of this study, and no attempt was made to correct the other observations to compensate for the slight over-estimation.

### Line-Intercept Versus Stem Count and Dry Weight.

The line-intercept method of sampling was used throughout this study, and in order to relate this method to others commonly used in

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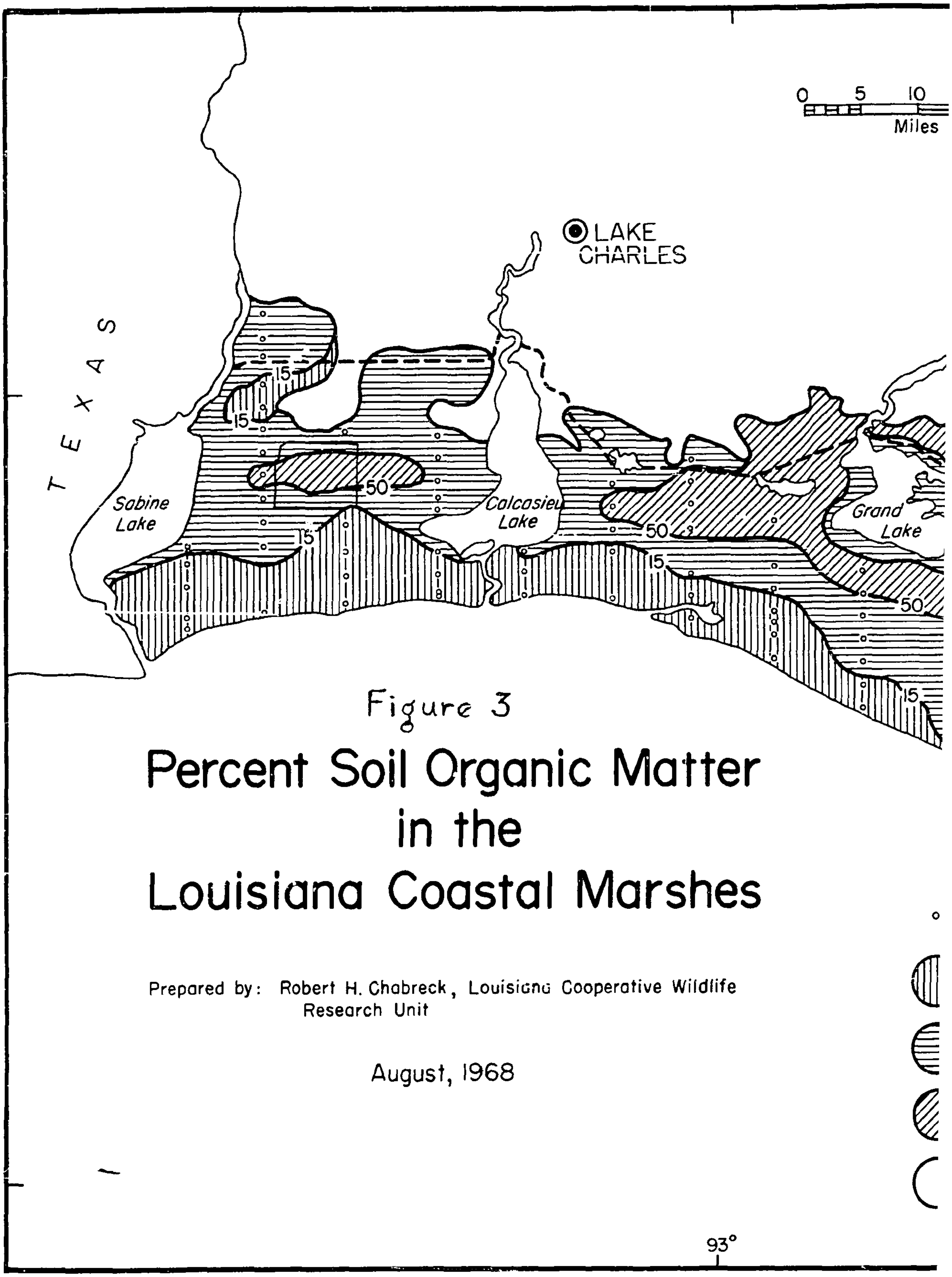


Figure 3

# Percent Soil Organic Matter in the Louisiana Coastal Marshes

Prepared by: Robert H. Chabreck, Louisiana Cooperative Wildlife Research Unit

August, 1968

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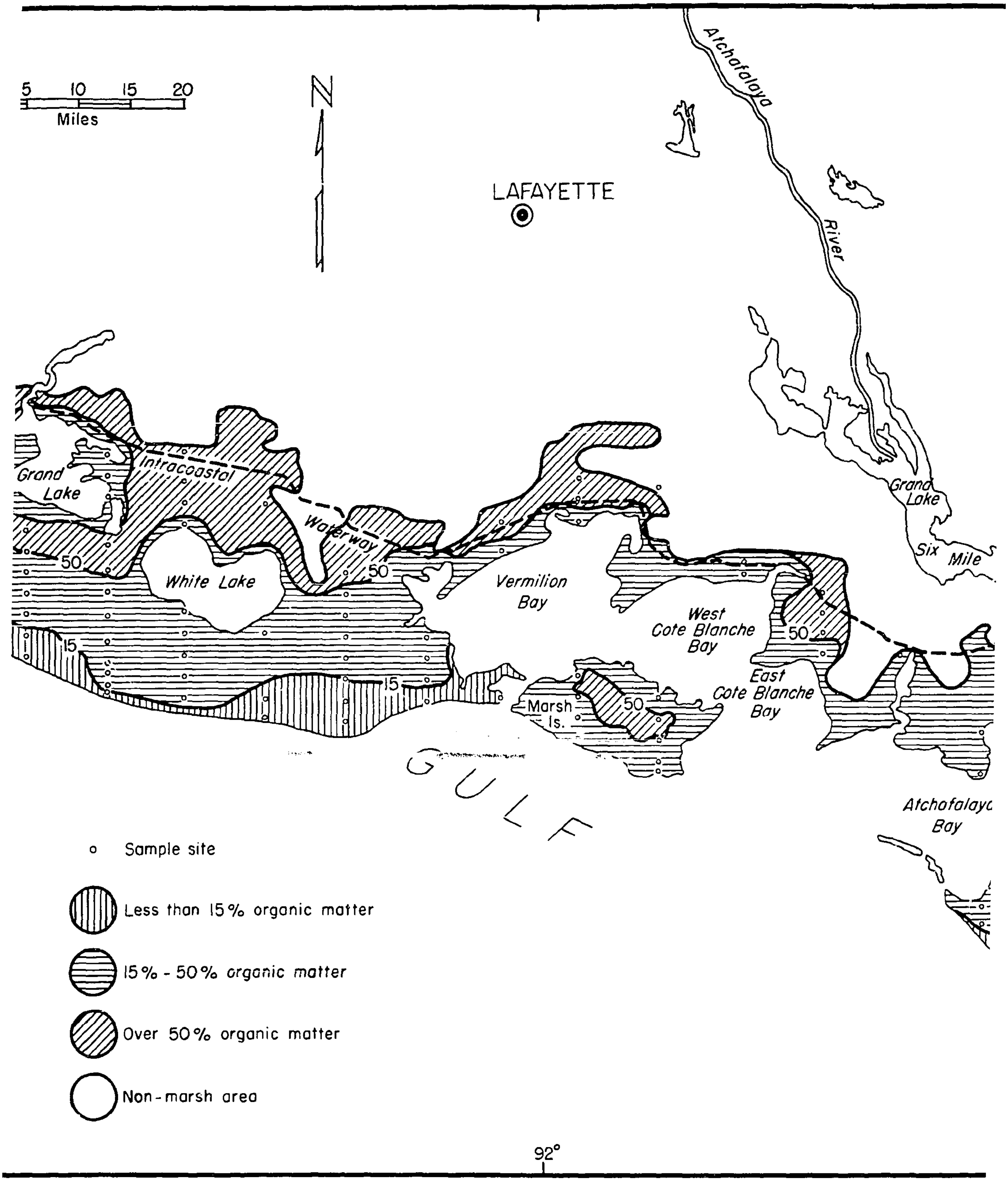


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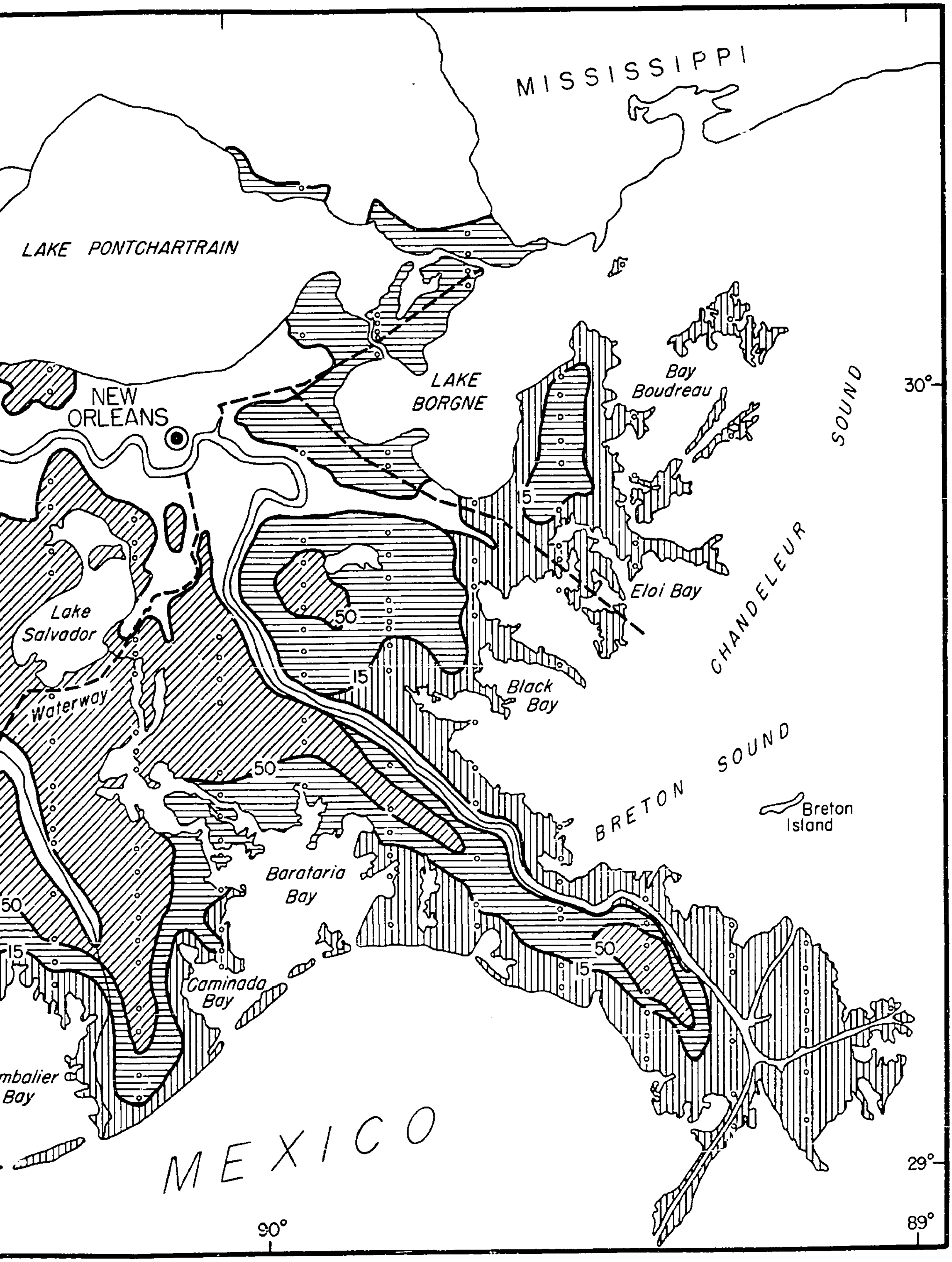


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Table 19. A comparison of plant coverage of vegetative types as determined by estimated and measured line-intercept values

| How Sampled | Vegetative Types | | | |
| --- | --- | --- | --- | --- |
| | Saline | Brackish | Intermediate | Fresh |
| | - - - - - - - - - - - Percent- - - - - - - - - - | | | |
| Estimated | 64.76 | 61.26 | 60.25 | 78.52 |
| Measured | 62.65 | 57.51 | 59.75 | 75.04 |

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sampling herbaceous plant communities, a species study was conducted. The results of this study are shown in Table 20 and compare the species composition, as determined by the line-intercept method, with the composition as determined by the dry-weight and stem-count methods. Three marsh types were sampled in order to include the principal species occurring along the coast.

The dominant species in the fresh marsh selected for this study was Panicum hemitomon. The composition as listed for this species varied less than 5 percent among the three methods of sampling. The remaining species in the fresh marsh made up approximately 10 percent of the composition by each method. All species, except Eleocharis quadrangulata, were included by each method. This species was very sparse in the area sampled and did not touch the ruler used in line-intercept sampling, although it did occur within the quadrat used for the other methods.

Spartina patens was classified as the dominant in the brackish marsh by all three techniques. The species composition varied only a small amount between the different sampling methods in this marsh type. However, large variation was found between techniques in the saline marsh type. Distichlis spicata and Spartina alterniflora were the only species to occur in sampling, and a size difference between the two species influenced the results of the dry weight and stem-count sampling methods. The dry weight per stem of Distichlis spicata averaged 0.50 gram based on 334 stems, and the mean from 275 stems of Spartina alterniflora was 3.97 grams. Consequently, the dry weight method favored Spartina alterniflora, and the stem count

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Table 20. A comparison of the plant species composition of vegetative types as determined by various vegetation sampling methods

| Plant Species | Sampling Methods: Dry Weights | No. of Stems | Line-Intercept |
|---|---|---|---|
| | - - - - - - - | Percent- | - - - - - - |
| Fresh type: | | | |
| Panicum hemitomon | 91.5 | 92.1 | 87.6 |
| Jussiaea uruguayensis | 2.2 | 1.4 | 0.9 |
| Alternanthera philoxeroides | 3.0 | 4.1 | 2.1 |
| Sagittaria falcata | 3.2 | 2.2 | 9.4 |
| Eleocharis quadrangulata | 0.1 | 0.2 | - - |
| Brackish type: | | | |
| Spartina patens | 71.1 | 66.6 | 64.4 |
| Distichlis spicata | 26.9 | 32.7 | 34.3 |
| Scirpus robustus | 2.0 | 0.7 | 1.3 |
| Saline type: | | | |
| Spartina alterniflora | 86.6 | 45.2 | 63.3 |
| Distichlis spicata | 13.4 | 54.8 | 36.7 |

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method favored Distichlis spicata. The line-intercept method, which is based on the amount of area occupied by each species, produced values which fell midway between the other methods of sampling (Table 20).

Although the species composition as determined by each method shows a similarity in results, information is lacking on the relationship of line-intercept measurements to the other methods of sampling. In order to determine the linear relationship between the different techniques, regression analysis (Li, 1964) was conducted on the data with line-intercept values as the independent variable.

Nine species were encountered in the three areas sampled, but only five species were included in the analysis. Species which were present in very small amounts and with missing observations were omitted. Those included were Panicum hemitomon, Sagittaria falcata, Spartina patens, Distichlis spicata and Spartina alterniflora. The linear relationship of line-intercept to dry weight is shown by species in Figure 4, and the linear relationship of line-intercept to the number of stems in Figure 5. Both graphs illustrate the increase in Y for a unit increase in X. The coefficient of determination ($r^2$) was included as a measure of the proportion of the variation in Y explained by the regression of Y on X.

The regression of dry weight on line-intercept was significant for all species tested; also, number of stems on line-intercept was significant for all species, except Spartina alterniflora. The area sampled contained wide variation in the size classes of Spartina

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Figure 4. Linear relationship of line-intercept method to dry weight for selected marsh plants

1. _Spartina alterniflora_ $Y = 39.25 + 70.00\ X$ ($r^2 = .643$)**
2. _Spartina patens_ $Y = 55.50 + 60.39\ X$ ($r^2 = .672$)**
3. _Panicum hemitomon_ $Y = 43.46 + 40.91\ X$ ($r^2 = .570$)*
4. _Distichlis spicata_ $Y = 9.30 + 37.89\ X$ ($r^2 = .462$)**
5. _Sagittaria falcata_ $Y = 1.01 + 15.65\ X$ ($r^2 = .629$)**

* $P > 0.05$
** $P > 0.01$

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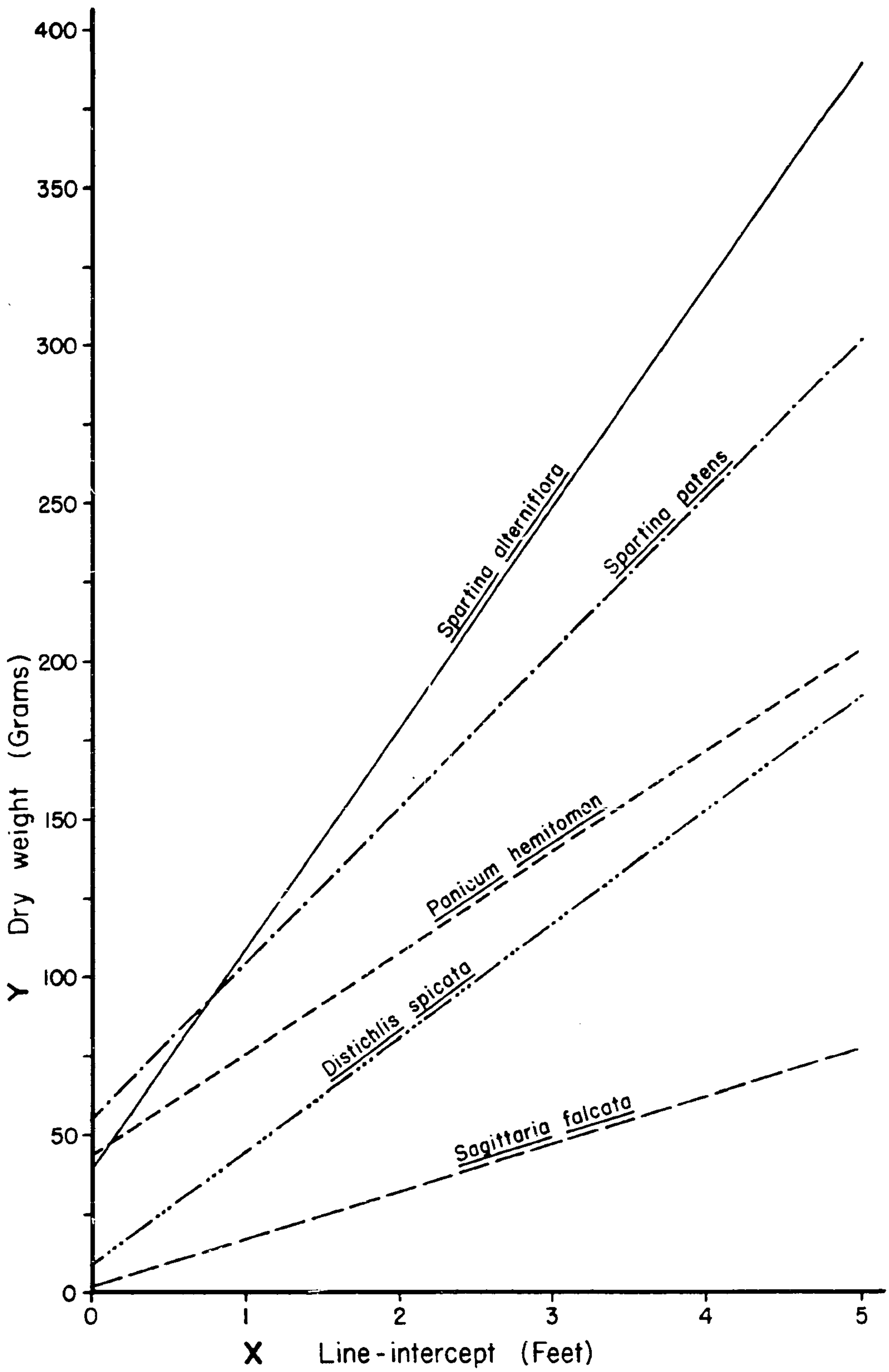


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Figure 5. Linear relationship of line-intercept method to number of stems for selected marsh plants

| | | |
|---|---|---|
| 1. | *Spartina patens* | $Y = 71.36 + 98.04\ X\ (r^2 = .607)^{**}$ |
| 2. | *Distichlis spicata* | $Y = 6.28 + 88.79\ X\ (r^2 = .618)^{**}$ |
| 3. | *Panicum hemitomon* | $Y = 9.37 + 56.85\ X\ (r^2 = .773)^{**}$ |
| 4. | *Spartina alterniflora* | $Y = 15.27 + 10.03\ X\ (r^2 = .376)$ |
| 5. | *Sagittaria falcata* | $Y = 0.52 + 9.02\ X\ (r^2 = .691)^{**}$ |

$^{**}P > 0.01$

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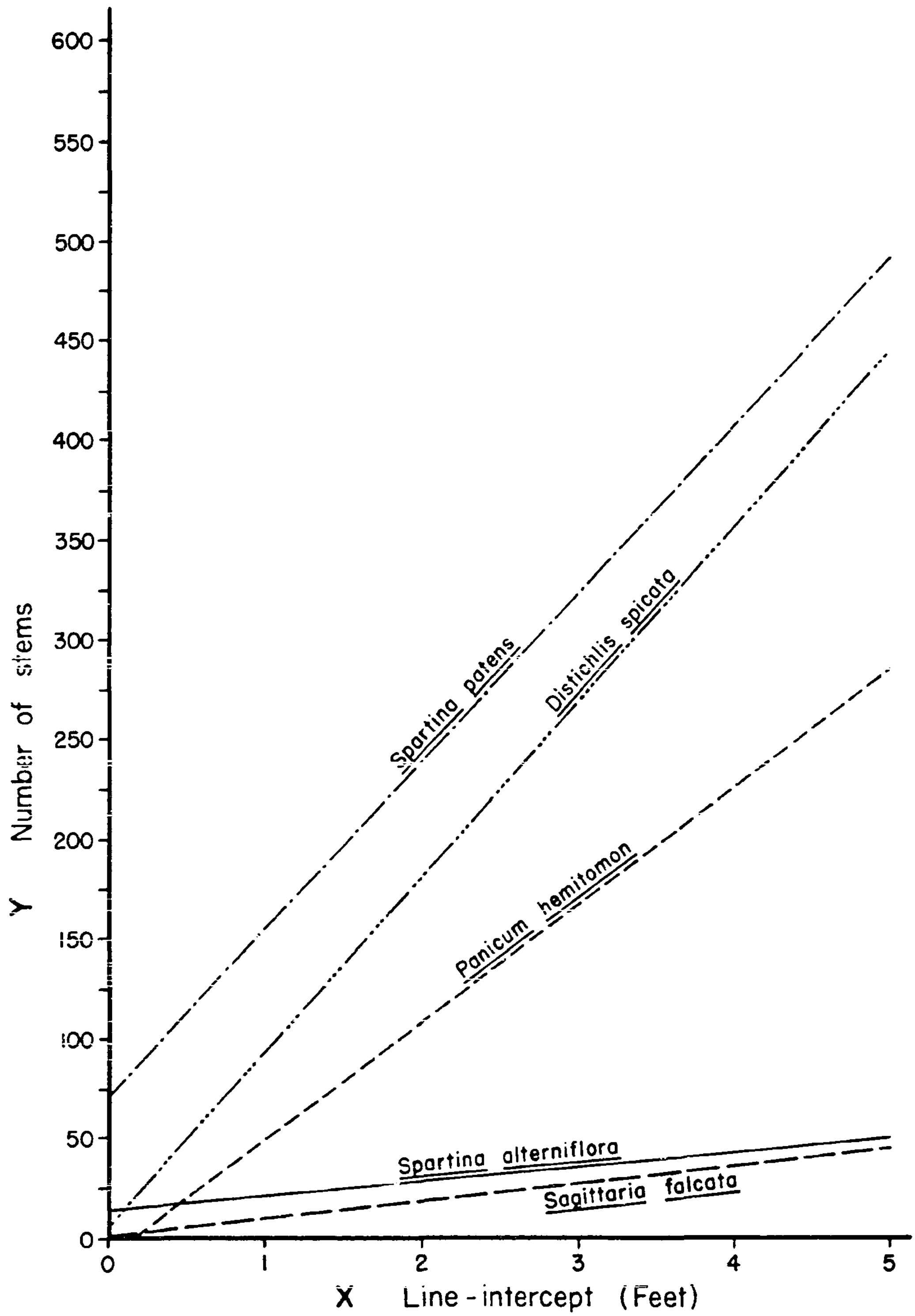


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_alterniflora_ plants. Many were mature plants and many were root sprouts which had recently emerged from the soil. Consequently, the linear relationship between the two methods on this species contains variation which would make the validity of predictions under this condition questionable.

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SUMMARY

Vegetation and soils were sampled in the Louisiana Coastal Marshes in August, 1968. Samples were taken along 39 north-south transect lines equally spaced along the coast. Two helicopters were employed for transportation, and vegetation estimates were made at 0.25 mile intervals along each transect line. Landings were made at 2-mile intervals for collecting soil and water samples, and for making ground measurements of the vegetation. A modification of the line-intercept method was used for vegetation sampling.

The Louisiana Coastal Marshes were subdivided into four vegetative types on a basis of the classification reported by Penfound and Hathaway (1938). The vegetation present along the transect lines was used in establishing the boundaries of the various types. The vegetative types (saline, brackish, intermediate and fresh) follow a general east-west direction and parallel the coast.

The coastal area was also subdivided into three marsh zones for descriptive purposes. The marsh zones were described by O'Neil (1949) and varied with age and origin. The Chenier Plain Marsh Zone occupied the western portion of the coastal marsh and the Inactive Delta Marsh Zone the eastern portion. The Active Delta Marsh Zone was the smallest of the three zones, and encompassed the marsh on the Mississippi River Delta.

Acreages were computed for the Louisiana Coastal Marshes, and for vegetative types and marsh zones within the area. The entire




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coastal marsh included 4.2 million acres. Fresh and brackish vegetative types were of almost identical size, totaling 61 percent of the marsh. Saline and intermediate vegetative types were of smaller size. The Inactive Delta Marsh Zone was the largest zone with 2.7 million acres. The Chenier Plain Marsh Zone contained 1.2 million acres and the Active Delta Marsh Zone encompassed 0.3 million acres.

A comparison was made of the changes in vegetative types and marsh zones over a 25-year period. A vegetative type map by O'Neil (1949) was compared with a map made at the time of this study (Chabreck, Joanen and Palmisano, 1968). Comparisons showed a widening of the saline and brackish vegetative types of the Inactive Delta Marsh Zone over the 25-year period. The Chenier Plain Marsh Zone showed a seaward movement of the brackish vegetative type during the same period.

A total of 118 species of vascular plants were found at sampling points along the transect lines. The species present in greatest amounts was Spartina patens, making up one-fourth of the vegetation in the coastal marshes. Other major species were Spartina alterniflora, Panicum hemitomon, Distichlis spicata and Sagittaria falcata.

The species composition was determined for the four vegetative types. The saline vegetative type was dominated by Spartina alterniflora along with Distichlis spicata, Juncus roemerianus and Spartina patens. The major species in the brackish and intermediate vegetative types was Spartina patens. Distichlis spicata was also abundant in the brackish type and Phragmites communis and Sagittaria falcata in the intermediate type. The fresh vegetative type included 93

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species with Panicum hemitomon the dominant. Other major fresh marsh plants were Sagittaria falcata, Eleocharis sp. and Alternanthera philoxeroides.

The plant species composition was determined for the three marsh zones. Spartina patens was the dominant species on both the Chenier Plain Marsh Zone and the Inactive Delta Marsh Zone. Sagittaria falcata and Distichlis spicata were also important species on the Chenier Plain, and Spartina alterniflora and Panicum hemitomon on the Inactive Delta. On the Active Delta Marsh Zone Phragmites communis was the major species, with other important plants: Myriophyllum spicatum, Spartina alterniflora, Alternanthera philoxeroides and Panicum repens.

The degree to which the marsh was vegetated showed little variation among vegetative types. The greatest plant coverage was in the fresh marsh, with the exception of the saline marsh of the Chenier Plain. Lowest plant coverage was found in the brackish vegetative type.

Water salinities for the coastal marshes averaged 18 ppt in the saline vegetative type, 8 ppt in the brackish, 3 ppt in the intermediate and 1 ppt in the fresh. Water salinities were slightly higher on the Inactive Delta Marsh Zone in corresponding vegetative types. The results from soil salinity tests were very similar to those from water salinity. In all cases, except the saline vegetative type, little difference was found.

Tests for soil organic matter showed a steady increase from the saline to the fresh vegetative type on both the Chenier Plain and Inactive Delta Marsh Zone. On the Active Delta Marsh Zone the

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opposite was found, and the percent organic matter decreased from the brackish to the fresh vegetative type. Mean values for soil organic matter were much higher in the Inactive Delta than in the Chenier Plain Marsh Zone.

A comparison of sampling techniques showed a slight tendency to over-estimate plant coverage from aerial observations. However, comparisons with ground measurements of the same points varied less than 7 percent for all vegetative types. Comparison of the line-intercept with stem count and dry weight showed similar results. Regression analysis showed significant relationships for all species tested except *Spartina alterniflora*.

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APPENDIX

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Table 21. Alphabetical listing of plants included in this study[a]

| Scientific Name | Family | Common Name |
|---|---|---|
| Acnida alabamensis Standley | AMARANTHACEAE | Belle-dame |
| Aeschynomene virginica (L.) B.S.P. | LEGUMINOSAE | Sensitive joint-vetch |
| Alternanthera philoxeroides Griseb. | AMARANTHACEAE | Alligator-weed |
| Aster sp. | COMPOSITAE | Aster |
| Avicennia nitida Jacq. | VERBENACEAE | Black-mangrove |
| Azolla caroliniana Willd. | SALVINIACEAE | Water-Fern, Mosquito-Fern |
| Baccharis halimifolia L. | COMPOSITAE | Groundselbush, buckbrush |
| Bacopa caroliniana (Walt.) Robins | SCROPHULARIACEAE | Carolina bacopa |
| Bacopa monnieri (L.) Pennell | SCROPHULARIACEAE | Waterhyssop |
| Bacopa rotundifolia (Michx.) Wettst. | SCROPHYLARIACEAE | Roundleaf bacopa |
| Batis maritima L | BATIDACEAE | Batis |
| Bidens laevis (L.) B.S.P. | COMPOSITAE | Bur-marigold |
| Borrichia frutescens (L.) Dc. | COMPOSITAE | Sea Ox-eye |
| Brasenia schreberi Gmel. | NYMPHAEACEAE | Water-shield |
| Cabomba caroliniana Gray | NYMPHAEACEAE | Fanwort |
| Carex sp. | CYPERACEAE | Carex |
| Centella erecta (L.F.) Fern | UMBELLIFERAE | |
| Cephalanthus occidentalis L. | RUBIACEAE | Buttonbush |
| Ceratophyllum demersum L. | CERATOPHYLLACEAE | Coontail |
| Cladium jamaicense Crantz. | CYPERACEAE | Saw-grass |
| Colocasia antiquorum | ARACEAE | Elephantsear |
| Cuscuta indecora Choisy | CONVOLVULACEAE | Dodder |

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Table 21. Continued

| Scientific Name | Family | Common Name |
|---|---|---|
| Cynodon dactylon (L.) Pers. | GRAMINEAE | Bermuda grass |
| Cyperus compressus L. | CYPERACEAE | |
| Cyperus odoratus L. | CYPERACEAE | |
| Daubentonia texana Pierce | LEGUMINOSAE | Rattlebox |
| Decodon verticillatus (L.) Ell. | LYTHRACEAE | Water willow |
| Dichromena colorata (L.) Hitch. | CYPERACEAE | Star sedge |
| Distichlis spicata (L.) Greene | GRAMINEAE | Saltgrass |
| Dryopteris thelypteris var. haliana (Fern.) Braun | POLYPODIACEAE | Southern marsh fern |
| Echinochloa walteri (Pursh) Ash | GRAMINEAE | Walter's millet |
| Eichornia crassipes (Mart.) Solms | PONTEDERIACEAE | Water-hyacinth |
| Eleocharis parvula (R.&S.) Link | CYPERACEAE | Dwarf spike-rush |
| Eleocharis quadrangulata (Michx.) R & S | CYPERACEAE | Four square sedge |
| Eleocharis sp. | CYPERACEAE | Spikerush |
| Eupatorium capillifolium (Lam.) Small | COMPOSITAE | Yankee-weed |
| Eupatorium sp. | COMPOSITAE | Boneset |
| Fimbristylis castanea (Michx.) Vahl. | CYPERACEAE | |
| Gerardia maritima Raf. | SCROPHULARIACEAE | |
| Heliotropium curassavicum L. | BARAGINACEAE | Seaside heliotrope |
| Hibiscus lasiocarpus Car. | MALVACEAE | Rose mallow, Marsh mallow |
| Hydrocotyle bonariensis Lam. | UMBELLIFERAE | |
| Hydrocotyle ranunculoides L. F. | UMBELLIFERAE | |

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Table 21. Continued

| Scientific Name | Family | Common Name |
|---|---|---|
| Hydrocotyle umbellata L. | UMBELLIFERAE | Water pennywort |
| Hypericum virginicum L. | GUTTIFERAE | Marsh St. John's-wort |
| Hymenocallis occidentalis (LeConte) Kunth | AMARYLLIDACEAE | Spider lily |
| Ipomoea sagittata Cav. | CONVOLVULACEAE | Morning glory |
| Ipomoea stolonifera (Cyrill.) Poir. | CONVOLVULACEAE | Morning glory |
| Juncus effusus L. | JUNCACEAE | Soft rush |
| Juncus roemerianus Scheele | JUNCACEAE | Black rush |
| Jussiaea alterniflora | ONAGRACEAE | Water primrose |
| Jussiaea uruguayensis Camb. | ONAGRACEAE | Willow primrose |
| Kosteletzkya virginica (L.) Roth | MALVACEAE | Pink hybiscus |
| Lemna minor L. | LEMNACEAE | Duckweed |
| Leptochloa fascicularis (Lam.) A. | GRAMINEAE | Sprangletop |
| Leptochloa filiformis (Lam.) Beauv. | GRAMINEAE | Red sprangletop |
| Limnobium spongia (Bosc.) Steud. | HYDROCHARITACEAE | Frog-bit |
| Lippia nodiflora (L.) Michx. | VERBENACEAE | |
| Lycium carolinianum Walt. | SOLANACEAE | Salt matrimony-vine |
| Lythrum lineare L. | LYTHRACEAE | Loosestrife |
| Myrica cerifera L. | MYRICACEAE | Wax myrtle |
| Myriophyllum heterophyllum Michx. | HALORAGACEAE | Variable watermilfoil |
| Myriophyllum spicatum L. | HALORAGACEAE | Eurasian water-milfoil |
| Najas quadalupensis (Spreng.) Mangus | NAJADACEAE | Southern naiad |
| Nelumbo lutea (Willd.) Pers. | NYMPHAEACEAE | American lotus |

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Table 21. Continued

| Scientific Name | Family | Common Name |
|---|---|---|
| *Nymphaea odorata* Ait. | NYMPHAEACEAE | White water-lily |
| *Nymphaea tuberosa* Paine | NYMPHAEACEAE | White water-lily |
| *Nymphoides aquaticum* (Walt.) Ktze. | GENTIANACEAE | Floating-heart |
| *Osmunda regalis* L. | OSMUNDACEAE | Royal fern |
| *Ottelia alismoides* Pers. | HYDROCHARITACEAE | |
| *Panicum hemitomon* Schultes | GRAMINEAE | Maiden-cane<br>Paille fine |
| *Panicum repens* L. | GRAMINEAE | Dog tooth grass<br>Chen-dent |
| *Panicum virgatum* L. | GRAMINEAE | Feather grass |
| *Panicum* sp. | GRAMINEAE | |
| *Paspalum dissectum* L. | GRAMINEAE | |
| *Paspalum vaginatum* Swartz. | GRAMINEAE | |
| *Philoxerus vermicularis* (L.) R. Br. | AMAEANTHACEAE | Salt alligator-weed |
| *Phragmites communis* Trin. | GRAMINEAE | Roseau |
| *Pluchea camphorata* (L.) D.C. | COMPOSITAE | Camphorweed |
| *Pluchea foetida* (L.) D.C. | COMPOSITAE | Stinking flea-bane |
| *Polygonum* sp. | POLYGONACEAE | Smartweed |
| *Pontederia cordata* L. | PONTEDERIACEAE | Pickerelweed |
| *Pontamogeton nodosus* Poir. | ZOSTERACEAE | Longleaf pond-weed |
| *Pontamogeton pusillus* L. | ZOSTERACEAE | Slender pondweed |
| *Ruppia maritima* L. | ZOSTERACEAE | Widgeon-grass |
| *Saccolepsis striata* (L.) Nash | GRAMINEAE | Bagscale |

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Table 21. Continued

| Scientific Name | Family | Common Name |
|---|---|---|
| *Sagittaria falcata* Pursh | ALISMATACEAE | Bulltongue |
| *Sagittaria latifolia* Willd. | ALISMATACEAE | Wapato |
| *Sagittaria platyphylla* (Engelm.) J. G. Sm. | ALISMATACEAE | Delta duck potato |
| *Sagittaria* sp. | ALISMATACEAE | |
| *Salicornia bigelovii* Torr. | CHENOPODIACEAE | Glasswort |
| *Salicornia virginica* L. | CHENOPODIACEAE | Glasswort |
| *Salix nigra* Marsh | SALICACEAE | Black willow |
| *Saururus cernuus* L. | SAURURACEAE | Lizzard's tail |
| *Scirpus americanus* Pers. | CYPERACEAE | Fresh-water three-square |
| *Scirpus californicus* (C.A. Meyer) Britton | CYPERACEAE | Hardstem bulrush, bull-whip |
| *Scirpus olneyi* Gray | CYPERACEAE | Three-cornered grass |
| *Scirpus robustus* Pursh | CYPERACEAE | Leafy three-square |
| *Scirpus validus* Vahl | CYPERACEAE | Soft stem bulrush |
| *Sesbania exaltata* (Raf.) Cory | LEGUMINOSAE | |
| *Sesuvium portulacastrum* L. | AIZOACEAE | Marsh purslane |
| *Setaria glauca* (L.) Beauv. | GRAMINEAE | Yellow foxtail |
| *Setaria magna* Griseb. | GRAMINEAE | Giant foxtail |
| *Solidago* sp. | COMPOSITAE | Goldenrod |
| *Spartina alterniflora* Loisel. | GRAMINEAE | Oyster-grass |
| *Spartina cynosuroides* (L.) Roth | GRAMINEAE | Hog cane |

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Table 21. Continued

| Scientific Name | Family | Common Name |
|---|---|---|
| *Spartina patens* (Ait.) Muhl. | GRAMINEAE | Marshhay cord-grass, Wire-grass |
| *Spartina spartineae* (Trin.) Merr. | GRAMINEAE | |
| *Spirodela polyrhiza* (L.) Schleid | LEMNACEAE | Duckweed |
| *Suaeda linearis* (Ell.) Moq. | CHENOPODIACEAE | Sea-blite |
| *Taraxacum officinale* Weber | COMPOSITAE | Dandelion |
| *Taxodium distichum* (L.) Richard | PINACEAE | Bald cypress |
| *Typha* spp. | TYPHACEAE | Cattail |
| *Utricularia cornuta* Michx. | LENTIBULARIACEAE | Horned bladderwort |
| *Utricularia subulata* L. | LENTIBULARIACEAE | Zigzag bladderwort |
| *Vallisneria americana* Michx. | HYDROCHARITACEAE | Wild-celery |
| *Vigna repens* (L.) Kuntze | LEGUMINOSAE | Deer pea |
| *Woodwardia virginica* (L.) Sm. | POLYPODIACEAE | Virginia chain-fern |
| *Zizaniopsis miriaceae* (Michx.) Doll & Aschers | GRAMINEAE | Giant cutgrass |

[a]Plant names are from the following sources:

(a) Fernald (1950)
(b) Gleason (1968)
(c) Hitchcock (1950)
(d) Small (1933)

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## VITA

Robert Henry Chabreck was born in Lacombe, Louisiana on March 18, 1933. He was graduated from Slidell High School in May, 1952, and entered Louisiana State University in June, 1952.

He attended Hinds Junior College, Raymond, Mississippi, during the Spring semester, 1953, and re-entered Louisiana State University in September, 1953, where he received a Bachelor of Science degree in Forestry in June, 1956. He then entered the Graduate School at Louisiana State University and received the degree of Master of Science in Game Management in June, 1957.

He was employed by the Louisiana Wild Life and Fisheries Commission for 10 years and in January, 1968, re-entered Graduate School at Louisiana State University and is now a candidate for the degree of Doctor of Philosophy in the Department of Botany and Plant Pathology.

He is married to the former Merle Marie Tabary of New Orleans and is the father of three sons and a daughter.



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**EXAMINATION AND THESIS REPORT**

Candidate: Robert Henry Chabreck

Major Field: Botany

Title of Thesis: Marsh zones and vegetative types in the Louisiana coastal marshes

Approved:

Clair A. Brown
Major Professor and Chairman

Max Goodrich
Dean of the Graduate School

EXAMINING COMMITTEE:

Charles A. Schexnayder

I. L. Forbes

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Date of Examination:

April 20, 1970

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